Chinese bonds as an alternative diversification asset to developed market bonds

by

Christiaan Wynand du Preez
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SUPERVISOR: Prof G Els
CO-SUPERVISOR: Prof I Botha

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Declaration of original work

I, **Christiaan Wynand du Preez** declare that this minor dissertation is my own unaided work. Any assistance that I have received has been duly acknowledged in the work. It is submitted in partial fulfilment of the requirements for the degree of MASTERS OF COMMERCE in FINANCE at the University of Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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Signature Date

Abstract

Globalisation has led to international asset classes becoming increasingly tightly correlated. This has effected diminishing diversification opportunities for international investors who invest in bonds, equity and property. New markets and asset classes must be explored to identify potential diversification opportunities. One such opportunity presented itself recently. In 2017, the Chinese government lifted its restrictions on the Chinese government's debt and opened its government bond market to international investors. Previously this market was only open to select investors who had limited access. This newfound opportunity led to the main research question of this study: could China (the world's second largest economy by GDP), be a potential diversification opportunity for global bond investors who mainly invest in developed market bonds?

Using weekly ten-year government bond yield data, this study made use of a correlation analysis, a causality test, bivariate and multivariate cointegration and innovation accounting to test the potential long- and short run relationships of Chinese government bonds when compared to the developed market bonds of Australia, Germany, Japan, the United Kingdom and the United States of America. It confirmed that there existed limited long- and short run relationships between China and the developed bond markets that were tested. The lack of cointegration confirms that Chinese government bonds offer a diversification opportunity for investors of global developed market bonds.

Key words

China, diversification, government bonds, investments, portfolio management, cointegration, comovements, long run relationships, short run relationships, Granger Causality, Engle-Granger, Johansen cointegration, correlation analysis, Australia, Germany, Japan, United Kingdom, United States.

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List of abbreviations

ADF: Augmented Dickey Fuller

ARIMA: Auto Regressive Integrated Moving Average

EU: European Union

EMU: European Monetary Union

G7: Group of Seven

GARCH: Generalized Autoregressive Conditional Heteroskedasticity

GCEA: Greater Chinese Economic Area

GDP: Gross domestic product

IMF: International Monetary Fund

MSCI: Morgan Stanley Capital International

MSCI EAFE: Morgan Stanley Capital International Europe Australia and Far East

OLS: Ordinary least squares

PP: Phillips-Perron

PPP: Purchase power parity

UK: United Kingdom

US: United States

USA: United States of America

VAR: Vector autoregression

VMA: Vector movingaverage

VEC: Vector error correction

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Dedication

I dedicate this study to my best friend and wife Jolinda, my daughter Elizabeth Grace and should we be so blessed in the future, to all my other children. Jolinda, thank you for being my rock and fortress. Your unconditional love and support carried me through the last two years. I will forever be grateful!

Chapter 1 Introduction

1.1 INTRODUCTION

“Here lies a sleeping giant, let her sleep, for when she wakes, she will shake the world” (Zhang, et al., 2012, p. 589). The French emperor Napoleon Bonaparte uttered these now famous words more than two centuries ago about China. Napoleon had the insight and vision to understand that the day the world’s oldest civilisation and most populous country arose, it would have a profound, lasting impact on the world. These prophetic words would not come to fruition in his lifetime, but more than 150 years later (Zhang, et al., 2012).

Arose she did. Napoleon likely referred to China’s military power and would not have been able to foresee the economic giant China would become, but that is exactly what has happened over the last four decades. In 1978, China began its economic reforms under the leadership of Deng Xiaoping. As will be discussed in more detail later, he had the insight and vision to transform China from an isolated, non-global economy, into a prominent player on the world economic stage. This decision was taken at a favourable time as China had tailwinds and benefitted from the Asian Tigers’ (Hong Kong, Singapore, South Korea and Taiwan) unprecedented growth. The whole East Asian economy grew at rates far exceeding those of their Western counterparts (Zhang, et al., 2012). Favourable regional economic developments coupled with China’s internal reforms, led it from an economy that was barely on the radar in the late 1970s, to the second largest economy by Gross Domestic Product (GDP) globally. This was mainly achieved by becoming the world’s largest exporter (Zhang, et al., 2012; International Monetary Fund, 2011; Hanemann & Huotari, 2016).

As China grew into a global economic powerhouse, it systematically opened its financial markets to the world. International investors scouting for higher yielding bonds in a low interest rate developed market environment, now had the chance to invest in this rapidly expanding economy. It also provided a potentially new diversification opportunity in an increasingly globalising world. Since the two Chinese stock exchanges, The Shanghai- and The Shenzhen Stock Exchange were created in 1990, numerous studies have found that they offer good diversification to developed market stock exchanges (Allen & Macdonald, 1995).

Whilst its equity markets have been open to international investors, the same was not true for the government bond market. China has been issuers of government bonds since 1950 but

international investors were not allowed to buy Chinese government debt. Notwithstanding the restricted market on the buy side, China's bond market grew to one of the largest bond markets in the world (Allen, et al., 2009). On July 3, 2017, a major change in the Chinese financial system gave rise to this study. This was the day (coinciding with the 20th anniversary of Hong Kong's reunification with China) that China opened its nine trillion US Dollar bond market to international investors via its bond connect program. Up to this point, international investors had very limited access to Chinese government bonds and owned a mere 2% thereof (Atkinson, 2017).

This study will set out to research whether this relatively newfound investment opportunity in China could potentially lead to diversification opportunities for investors. Then the premise will be developed that the world has systematically become more globally connected over the past seventy years, with a noticeable acceleration seen since the turn of the century. Many studies have found that globalisation inevitably leads to closer comovements of financial markets, reducing the opportunity for global diversification. This is especially true for developed government bond markets and has led to an undeniable closer movement of yields since the 2008 financial crisis (Belke, et al., 2017). As will be evidenced in the literature review, studies conducted in the 1960s-1980s all confirmed that significant diversification opportunities existed for United States investors who were willing to invest in global markets. This was true for both bonds and equities. Studies from the late eighties started questioning whether this remained true and as time went by, many studies still found diversification in international markets to be beneficial, but less significant in terms of volatility and returns.

1.2 BACKGROUND

This study will focus on China as a diversification opportunity for international bond investors. For the reader to understand the context, a high-level background on a couple of topics will be provided. Firstly, the changes in the financial system of China over the last three decades will be discussed. During this time, China went through radical change and adopted a more Western financial system. Corporations could now raise capital through equities and bonds and were not so overly reliant on state-controlled banks. China also recently opened its markets to international bond investors, making it a potential destination for international investors. This will be followed by a discussion on globalisation and diversification.

1.2.1 China

Some researchers regard the current growth of China as a mean reversion of a long-term cycle. They indicate that China was the biggest world economy in the early 18th century (Barth, et al., 2009; Dixon, 2015). During this time, the GDP of a country was intricately linked to its population since agriculture was the main contributor. This changed during the industrial revolution as countries were now able to produce alternative goods to agricultural products and deliver non-agricultural services (Barth, et al., 2009).

Despite being self-isolated from global markets and capital, China had a well-developed financial system before 1949, so much so that in the first half of the 20th century it propelled Shanghai to an important financial centre in Asia. Shanghai showed early signs of moving to a more global financial centre. For example, whilst the majority of the country still adhered to more traditional ways of settling disputes, Shanghai started using a "Western" court system, which was one of the earliest indicators of China starting to integrate more with the Western world (Allen, et al., 2009).

The People's Republic of China, as it is known today, was formed in 1949. Before this formation, companies were allowed to operate within a capitalistic model, but this changed in 1950 when all companies where nationalised. From this time up until the reforms of 1978, China operated on a single bank system under the People's Bank of China (Allen, et al., 2009). This bank was an old banking system concept, formed in the socialistic regime to control financial transactions centrally (Berger, et al., 2009). However, having a single, centrally controlled banking system could hamper economic growth. Studies have shown a more balanced banking system to be an important driving factor for growth (Barth, et al., 2009). The People's Bank of China fulfilled the functions of both a Reserve Bank and a commercial bank. It resulted in a highly concentrated financial system as the bank controlled upwards of 90% of all financial assets and facilitated nearly every financial transaction made in the country (Allen, et al., 2009). Such a system that was overly dependent on banks (or in this case a single bank), would be unsustainable in the long term as companies had no other avenue to raise capital. Corporations in the US for instance, had many other alternatives to banking through which they could raise capital internationally, such as issuing stocks and bonds (Barth, et al., 2009).

In 1970, China decided to end its isolated existence and systematically opened its economy to the rest of the world. This decision had far-reaching implications for the country's financial and banking systems (Barth, et al., 2009). A welcome change to its highly governmental

controlled banking alongside other financial reformations came to dawn late in 1978. The People's Bank of China was decentralised and whilst still operating as a government bank, it functioned independently from the ministry. Three other banks, The Bank of China, the Agriculture Bank and the People's Construction Bank of China, were given mandates to deal with specific sectors of the economy (Allen, et al., 2009; Berger, et al., 2009). The Bank of China would be responsible for foreign trade and investment; the Agricultural Bank was to focus on rural areas where people mostly made a living out of agricultural activities; and the People's Construction Bank of China would focus on fixed investment, often relating to manufacturing and construction (Allen, et al., 2009).

The idea behind having other banks focussing on specific areas, was to transform the People's Bank of China to operate exclusively as the central bank. In 1984, the Industrial and Commercial Bank of China was incorporated as the fourth state bank and relieved the People's Bank of China of its remaining transactional responsibilities. This mandated the People's Bank of China to focus solely on being the central bank. These banks (known as the big four) were prominent and formed the backbone of the Chinese financial system. They were, however, not exclusive institutions and intermediaries who could operate in China. Large scale growth was evident outside the big four, mostly in the form of regional banks in the coastal areas (Allen, et al., 2009). China is a large country with 31 provinces, contributing to the necessity of regional banks (Berger, et al., 2009).

A watershed moment for China's financial system came in 1990, when its two stock exchanges, The Shanghai Stock Exchange and the Shenzhen Stock Exchange were incorporated (Allen, et al., 2009). These stock exchanges were established differently to those in New York and London for example, which were established by the need for raising capital and are privately owned. The Chinese stock exchanges were incorporated by the state and remain state controlled (Li & Zhou, 2016). Notwithstanding state ownership, it had a positive impact on the financial system. For the first time, Chinese companies would have the opportunity to raise capital in the 'free market' and not be so overly reliant on exclusive financing from local banks. It also opened an opportunity for investors to partake in the Chinese economy in a way that was not possible before (Allen, et al., 2009). Whilst this was a significant step in opening its economy to the world, China was slow to allow its citizens to buy foreign assets and by April 2006, the only foreign assets that citizens could invest in was fixed income. It was not until 2007 that the government relaxed the restrictions and allowed its citizens to invest in foreign equity markets (Barth, et al., 2009).

Despite the outward restrictions, the stock exchanges were an immediate success and experienced rapid growth during the 1990s, proving that foreign investors had an appetite to invest in Chinese equities. Both stock exchanges grew in market capitalisation and experienced steadily increasing trading volumes, indicating high engagement by local and foreign investors. Active participation, trading and speculation were evident in the stock exchanges as they both experienced deep corrections and high volatility at times (Allen, et al., 2009).

The stock exchanges were not established without their share of criticism. The high volatility caused some investors and analysts to perceive these stock exchanges as higher risk investments than most other stock exchanges. This, coupled with criticism of the application of financial laws, prompted some highly regarded Chinese economists in the 1990s to question the necessity of having these stock exchanges. Some even went so far as to call them casinos and held that investing in them was no different from gambling (Li & Zhou, 2016).

Alongside the growth of the equity market, real estate went from a non-existing market to a market that compares well in size with equities. Aiding these financial developments was the development of a financial legal framework (Allen, et al., 2009). During the 1980s and 1990s several new laws were developed to help regulate the transforming financial system. Acts on property, intellectual property, patent rights, capital flows, product regulation and how companies could structure their shares to become privatised were signed into law (Berger, et al., 2009). China developed an experimental bankruptcy law, only as late as 1986, whilst the company's law was passed in 1999. This law oversaw governance of organisational structure, accounting regulations and mergers and acquisition requirements. Securities issuance and trading were consequently regulated for the first time in the country's history. These laws contributed to some stability and clarity in the financial system, setting the scene for further development and growth (Allen, et al., 2009). It should be noted here that whilst these laws aided in bringing about stability, critics have questioned its application and some perceive them to be a mere controlling mechanism of the state. There are, for instance, numerous examples where the state and corporations contravened these laws (Li & Zhou, 2016).

Of particular interest to this study is the development of the Chinese bonds market. Alongside the developments mentioned above, the bond market was established by 1950 when the Ministry of Finance started issuing government bonds. The first round of bond issuance was short lived and suspended by 1958. In 1981, commensurate with the accelerating pace of China's construction industry, a need arose to raise capital since the industry experienced a

funding shortfall. The government bond market was subsequently opened again and this time for good. (Bai, et al., 2013).

This development was good for the Chinese economy because of the following: firstly, a well-established bond market is important to a modern economy as the liquidity and cash flow benefit investors, particularly pension funds and retired citizens. There can be no doubt that a well-functioning bond market supports macroeconomic activity. Secondly, the bond market assisted the banking sector which at the time was experiencing high levels of nonperforming loans. Bonds assisted the banks in diversifying credit risk (Huang & Zhu, 2009).

Despite the large Chinese population and quickening financial growth, the Chinese government bond market remained small and from a global perspective, insignificant. Initially, China had only a primary market (which was not unusual for many government bond markets up to the 1980s) and bonds had no legal platform on which it could be traded. The prospecting bearer bought the instrument and kept it until its maturity date (Bai, et al., 2013).

Following global developments in security trading, China selectively opened a secondary market for bonds in 1988. By 1990, alongside the establishment of the stock exchanges, it transformed its primary-only bond market to a fully functioning bond market consisting of channels to trade. To align with global practice further, an experimental underwriting system for issuance of government bonds was conducted in 1991. This led to a primary dealer system by 1993. An auctioning system, as is still customary around the globe, was established and by 1996, all government bonds were issued by auction (Bai, et al., 2013).

At the turn of the century, China started to open its bond markets to international investors, but the initial opening was small and gradual. In 2002, the first foreign investors could purchase Chinese government bonds under the Foreign Institutional Investor program. This allowed a mere 279 institutional investors the opportunity to buy government debt worth USD 80 billion. This quota was increased in 2011 as China now attempted to have its currency included in the Special Drawing Rights basket of the IMF (Manyapu, 2018). This limited international participation caused low levels of volatility between 2000-2011. Whilst the rest of the world were reeling from the volatile effects of the 2008 financial crisis, China experienced relative stability (Piljak, 2013).

Despite the systematic growth of China's bond market, it was still less active in trading volumes when compared to that of developed nations such as the United States. It was also low when compared to the countries total savings and had fewer investors and market

participants than the stock exchanges (Huang & Zhu, 2009). A definite contrast existed between corporations (especially construction companies) which still preferred international bonds over their local counterparts, to finance their operations (Huang & Zhu, 2009; Fung, et al., 2019).

The first major step to rectify low issuing and trading came with policy changes in 2014. This will be discussed in detail in the literature review. This change in policy had an almost immediate effect, proving that the appetite for investing in Chinese bonds existed. Only two years later, by 2016, Chinese corporations had raised bonds to the value of 15 trillion Renminbi (RMB) (USD 2.2 trillion), state owned enterprises raised RMB 16 trillion (USD 2.4 trillion) with the government issuing RMB 35 trillion (USD 5.3 trillion). In only two years, RMB 62 trillion was raised by various bonds in China. This increased to RMB 41.1 trillion in 2017. It is clear that the policy change had a direct impact on the market, as outstanding bonds were only RMB 5 trillion in 2005 (Fung, et al., 2019).

In a continued effort to meet the IMF's freely usable currency requirements, policy amendments were made which would further reduce the restrictions on international investors. By July 2015, China opened its bond market to foreign central banks and foreign sovereign wealth funds (Manyapu, 2018). Despite this development, Chinese government bonds still differed from other global bond markets as they were fragmented and functioned in a system that was difficult to understand. There were also differing regulatory requirements for the issuance of bonds as they were not issued and traded centrally, but by the stock exchanges and an intrabank system (Fung, et al., 2019).

Arguably the most momentous policy change came on July 3, 2017, when China launched its Hong Kong Bond Connect program. This allowed for Northbound trading, whereby investors from Hong Kong and the rest of the world were able to buy Chinese government bonds. Fund managers, for instance in the USA and South Africa, were now free to purchase Chinese government bonds (Fung, et al., 2019)

1.2.2 Globalisation and diversification

A great deal has been said and written about diversification and clichéd sayings such as "diversification is the only free lunch in investing" and "don't put all your eggs in one basket" have become synonymous with investing (Cayon, 2018; Elazar, 2018; Peterson, 2019). Peterson (2019) indicates the benefits of international diversification and specifically highlights the benefits of diversifying between emerging and developed markets. He refers to the globalisation trend as a new market reality that is unlikely to evaporate, despite the recent rise

of nationalism and populism around the globe. He indicates that emerging markets outperformed their counterparts in developed countries in 2017, and that the trend reversed again in 2018. He concludes that there is no fixed pattern to the often erratic behaviour of the markets and that investors should not attempt to “time the market”, but rather diversify into differing asset classes and diverse types of economies. He uses data from Charles Schwab to highlight the erratic behaviour of markets and the value that spreading investment risk across economies have had in the past. In Figure 1:1 he indicates what the advantage of a diversified portfolio was during the infamous dotcom bubble and the 2008 recession (Peterson, 2019).

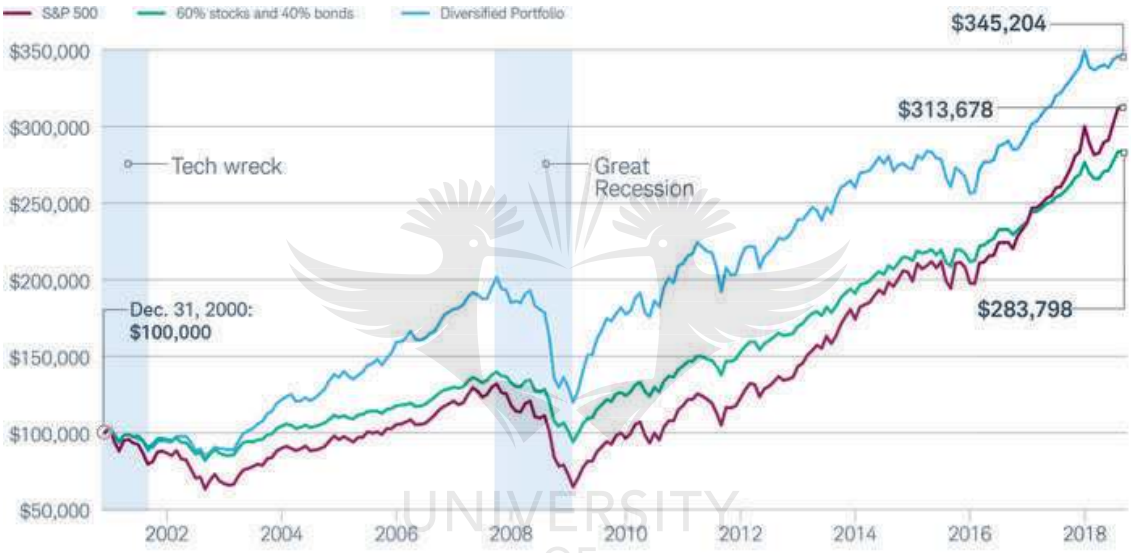

Figure 1:1: Diversified portfolio 2000-2018

Source: Charles Schwab Research (2019)

Peterson (2019) uses stocks and bonds as an example but argues that the same holds true for any asset class and proposes the diversification of assets globally.

It is well documented that diversification helps to reduce risk, if the investor spreads those risks among non-correlated asset classes. Diversification is achieved by investing in a variety of asset classes that are ideally not strongly correlated, to reduce volatility in a portfolio and protect the investor from default risk (O'Sullivan & Sheffrin, 2003). Diversification can take many different forms and traditionally, spreading investments geographically gave investors much needed diversity in their portfolios, be it in bonds, property or shares. The interconnectedness of the so-called global village, reduced the global diversification

opportunities that existed pre-globalisation. This was evident in the 2008 financial crises and the recent Coronavirus pandemic.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTION

Singal (2013) argues that there are many considerations for investment professionals to consider when constructing a portfolio, but none are more important than the risk and return factors of the underlying securities. In every investment or investment portfolio there exists a risk-return trade off that broadly states that investors should be compensated more for investments that have higher risk (a term used interchangeably with volatility and in most cases refer to the volatility of the investment rather than the risk per se). Whilst risk management and returns are two parts of the same coin, this study will not include research on the return side thereof but will be concerned only with risk management and diversification. Clients are generally risk averse and would prefer reduced risk in their portfolios, whilst ironically hoping not to give up returns in exchange for reduced volatility. It is also often true, that investors would settle for lower returns if they could be assured that they will not suffer catastrophic losses (Singal, 2013).

Diversification takes on many forms. One technique is to diversify within a specific asset class: for example, buying a variety of underlying shares, but in different companies and different industries on the same stock exchange. Another would be to diversify among different asset classes: so, for example, to have a portfolio that consists of shares, bonds, money market instruments, commodities and alternative investments. A powerful diversification tool according to Singal (2013) is international diversification. He argues that countries differ economically: whereas, for example, the USA's economy is strongly reliant on professional services and innovative research, China and India's economic output leans more toward manufacturing. Countries also differ in political regimes. Europe, for instance, has a long history of democracy, contrasting with the East Asian countries that are now experimenting with democracy, or China that remains a communistic country. International diversification benefits the investor since different world events should affect global economies differently. This in turn should assist in mitigating risk (Singal, 2013). International diversification results in an investor not being overly exposed to a single country or geographical risk.

Whilst the above remain true, there are many studies that have found the world to have become more integrated and that these traditional global diversification opportunities have been reduced, but still do exist. Moosa, Tawadros and Hallahan (2015) recently did a study that set out to determine whether international diversification and hedging across sectors are

still beneficial. They argue that an international diversification strategy made sense in the 1960s and 1970s when markets were much more segmented and consequently functioned independently of one another. Ironically, this international diversification opportunity was limited for investors, as it was difficult to invest internationally and the limitations that created the diversification opportunity in the first instance, was the very reason many could not benefit from the opportunity.

Restrictions on trade and capital were subsequently lifted and the global phenomenon started to take shape (Moosa, et al., 2015). As it became easier for counties to do business and trade, it became easier to make use of the international diversification opportunities. This, coupled with a slow reduction in domestic bias (Baxter & Jermann, 1997), led to the closer movement of markets, whereby international news or economic events affected stock markets in a similar way across borders (Moosa, et al., 2015).

As will be seen in the literature review, studies in the late 1980s and 1990s questioned whether the findings of earlier studies on international diversification were still valid. These studies observed an increasing globalised and connected world. By the early 2000s, studies found this suspicion to be justified as international diversification were proven to be less effective than decades earlier. It mostly found that international diversification was still possible but diminishing (Kalra, et al., 2004). Other studies proved that rising stock market correlation could be explained by integration and globalisation (Campa & Fernandes, 2006).

Various studies that will be discussed in the literature review, found that there are still good diversifying opportunities from developed markets into emerging markets. This study will investigate whether there are diversification opportunities for developed markets in the recently opened Chinese government bond market.

Hence, the research question is formulated as follows: **Do international diversification opportunities exist within China for developed bond market investors?**

To answer the research question, the sub-questions to be addressed are:

- Is there evidence of causality among these bond markets?
- Is there evidence of long run relationships among these bond markets?
- Is there evidence of short run relationships among these bond markets?

These results will be interpreted together to determine if diversification opportunities exist.

1.4 RESEARCH METHODOLOGY

1.4.1 Methodology

This study will be of a quantitative nature, whereby the ten-year government bond yields of China will be tested for cointegration against five developed bond markets. The five developed markets are that of Australia, Germany, Japan, the UK and the USA. A correlation analysis and causality test will indicate the underlying relationships among these markets. Thereafter, cointegration tests will be conducted to determine if there are long run relationships and if they display strong long-term comovements. Should there be evidence of cointegration, it would imply that limited diversification opportunities exist. After testing for cointegration and long run relationships, innovation accounting will be done to determine if shocks to any of the variables have a lasting impact on Chinese bonds, thereby testing short run relationships.

1.4.2 Data collection and analysis

The data used in this study will be the weekly, ten-year government bond yields of the countries mentioned above. This data has been collected from Bloomberg and analysed using EViews software. Before tests for cointegration will be conducted, the Augmented Dickey Fuller and Phillips Peron unit root tests will be done to determine stationarity. This will be followed by a correlation analysis, which is one of the oldest methods to test for underlying relationships. Once this is done, the Granger causality test will be used to test for causality among the markets. This will be followed by the Engle Granger two step method and Johansen tests, which will be used to test for cointegration. Finally, short run relationships will be tested by using an impulse response function and variance decomposition.

1.5 LIMITATIONS OF THE STUDY

As with all quantitative studies, this study has several limitations that should be noted. The first is that Chinese bond markets only opened for international investors three years ago. Most studies on international diversification use time periods of ten or fifteen years to determine potential long run relationships. This study is limited to a shorter time since a longer time is not available.

The second limitation stems from the fact that China was tested against only five other international bond markets. Whilst they have been carefully selected and represent in the region of 85% of the international bond market capitalisation, they do not represent all

developed markets and cannot fully account for all developed market investors who are seeking international diversification.

The final limitation of this study is that it explores only a diversification opportunity from a purely quantitative perspective and does not account for other potential deterrents of investing in China. Many investors are still cautious about China because its financial system is still considered generally weak, with an underdeveloped banking system (Allen, et al., 2009). Others express concern about investing in a country that carefully controls its currency to not appreciate too rapidly, as this would adversely affect the export market (the cornerstone of the Chinese economy) (Navarro & Roach, 2012).

1.6 SIGNIFICANCE AND MOTIVATION

The significance of this study stems from the fact that China has emerged as a global economic powerhouse. It recently opened its government bond market to international investors. Despite this, there is still limited research done on Chinese government bonds, causing a gap in knowledge (Fung, et al., 2019).

For decades, China restricted international investors from investing freely in its financial markets. Despite the opening of its equity markets in the 1990s, government bonds were not accessible, except for a couple of select investors who had to adhere to strict limitations. The opening of its bond market could be significant for portfolio managers with a global mandate. China could potentially be an extremely attractive destination for investors who want to diversify their portfolios. China is unique in the sense that it has become the world's second largest economy but is still showing GDP growth that is superior to developed markets and the other largest economies in the world such as the US, the UK, France, Italy and Germany. The World Economic Outlook (WEO) of the International Monetary Fund (IMF) predicted at the beginning of 2020 that developed economies would grow by 1.6% in 2020, compared to China that was expected to grow by 6% (International Monetary Fund, 2020). Whilst the Coronavirus wreaked havoc on international growth, the principle remains that China is growing significantly faster than its developed counterparts.

The fact that their bond markets are now open, gives investors a unique opportunity to invest in a country with a large GDP, yet it grows like an emerging market. However, this would have little value from a diversification perspective if it turns out that Chinese bond yields move in unison with its developed counterparts. Whilst there may be benefits from a yield perspective, this study is concerned with the opportunity for diversification. The hypothesis is that China

does offer a diversification opportunity, as it has different underlying economic fundamentals when compared to that of other developed markets.

Whilst the above indicates the potential for investors, there are also academic benefits and significance to this study. There is currently a research gap, as studies on Chinese government bonds are limited and no studies have been conducted to specifically test for comovements between China and other developed markets since China opened its market in 2017. As will be seen in in the literature review, there are numerous studies that test for cointegration among developed markets, among developed markets and emerging markets and among Asian markets. There is, however, currently a knowledge gap as to whether China could offer a diversification opportunity for international bond investors. This study acknowledges that the short time period of only three years, could be why this has not been tested yet. This study will attempt to close that gap and provide a basis for similar future studies as the time period extends.

1.7 CHAPTER OUTLINE

Table 1:1: Summary of chapters and content

CHAPTER	CONTENT
Chapter 1:	**Introduction and background to the study** The chapter serves as an introduction that provides some background on China and diversification. It clearly defines the problem statement and the research question that this study will seek to answer. The motivation of the study is furthermore discussed and finally provides a high-level overview of the methodology used and how data was collected.
Chapter 2:	**Literature review** This chapter will assess a broad range of studies conducted on the topics of diversification and cointegration in general, but also studies with a specific focus on bonds and on China. The review will discuss the findings of earlier studies on these topics and identify the research gap to be closed in this study. The literature review is not only helpful in determining previous research on these topics, but also helpful in understanding how previous research was conducted and which methodologies were employed.
Chapter 3:	**Research methodology**

	This chapter will describe in detail the specific methodology that was used to conduct this study. This includes the sampling of the countries and data, research instrument and specific tests conducted. This methodological discussion is important as it will explain how this study built on the methodologies of previous studies.
Chapter 4:	**Analysis of results** Chapter four provides detailed results of all tests that were conducted. These results are interpreted from an econometric point of view to draw conclusions. An in-depth discussion of the results and their implications will be explored and conclusions will be drawn based on these findings.
Chapter 5:	**Discussion, conclusion and recommendations** In this chapter the findings will be linked to the research question and objectives to ensure that the initial research questions are answered. Shortcomings and limitations of this study will also be discussed, along with recommendations for future studies.

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Chapter 2 Literature review

2.1 INTRODUCTION

This study will focus on Chinese government bonds as a potential diversification opportunity for international bond investors. It will become clear in this literature review, that researchers in the late 1980s started asking if international diversification opportunities still existed with the rise of globalisation. Many researchers found that whilst international diversification opportunities still exist, it has undeniably been reduced due to closer comovements of equity and bond markets. China recently opened its bond market to international investors, which potentially created a new diversification opportunity.

Whilst the primary concern of this study will be Chinese government bonds, a literature review of a wider array of topics is warranted as they are interconnected with the study at hand. Firstly, diversification theories will be discussed as these form an integral part of what this study sets out to achieve. To prove or disprove ultimately that diversification opportunities for Chinese government bonds exist, diversification and the important research done thereon need to be understood. The diversification section will not focus exclusively on bonds but also provide a high-level discussion of some of the diversification studies that were conducted on stock markets. These studies will lay an important foundation in understanding market comovements and the concept of international diversification. Despite bonds being a separate asset class, fundamentals such as correlation, long run relationships and temporary shocks can, in principle, be tested in the same manner for all asset classes. The theoretical framework provided for diversification as a concept is valuable in these studies, especially since more literature exists on equity markets than on bonds. Thereafter, the study will consider the bond market, before focusing specifically on Chinese government bonds. A short discussion on globalisation will follow to highlight important findings that directly impact international diversification strategies.

Following this broad overview, the focus will shift to more specific aspects of literature that relate closer to this study. A review will be done on diversification and cointegration studies that pertinently focus on government bonds. This study will use correlation, causality, cointegration and innovation accounting as methodologies. These will provide insight into which tests were conducted, how they were conducted and what their results were. Some

results on emerging markets and Chinese bonds will be valuable as they create comparable results.

Finally, a comprehensive review will be presented on research conducted on China. This section has a twofold purpose. The first is to review the literature that assists in understanding China and the developments of its economic system. This is important as Kroeber (2016) argue “Understanding China’s unique and resilient political system is a prerequisite for making sense of the country's economic past, present, and future” (Kroeber, 2016, p. 1). The second is to understand what research has been conducted on China, and specifically on Chinese bonds. The study will then attempt to build on these studies to close a literature gap.

2.2 DIVERSIFICATION

The starting point for any study on diversification could arguably not be anything other than Markowitz’s (1952) modern portfolio theory – a breakthrough study for which he received the Nobel Prize in Economics was cited more than 42 000 times by researchers early 2020.

The basis of his theory is the assumption that investors generally perceive returns on their investment as positive, but experience variance (often called volatility) as negative. Further to this assumption, he accepts that investors usually want the maximum return on their investment. In a perfect world, this would mean that investors could analyse a range of potential securities to invest in and simply invest all their money in the single security that would offer the highest return. According to Markowitz, this way of thinking about investments should be rejected, as market imperfections exist and that could have a detrimental effect on an undiversified investment. He argues that a diversified portfolio is in every instance of investing preferable to a non-diversified portfolio and that any theory or practice that contradicts this rule should be rejected (Markowitz, 1952). “Diversification is both observed and sensible; a rule of behaviour which does not imply the superiority of diversification must be rejected both as a hypothesis and as a Maxum” (Markowitz, 1952, p. 77).

Markowitz (1952) is one of the earliest researchers to argue that investors could not reasonably expect to diversify a portfolio and still expect the maximum desired return, whilst simultaneously expecting reduced variance. He argues a principle that remain true to this day: portfolios with higher variance will often produce higher returns and *vice versa* (Markowitz, 1952). The end goal of diversification is then not to maximise returns or minimise variance, but rather to mitigate risk. This could only be accomplished by investing in a variety of

uncorrelated securities. A diversified portfolio should help an investor accomplish this goal, as securities are not equally affected by the same events or news (Markowitz, 1952).

Markowitz' theory is of the utmost importance to this study, since the goal of testing for potential to diversify into China should not be regarded as an effort to maximise return or reduce volatility, but rather to determine whether these bonds could be used as a risk mitigation instrument in international portfolios. It should be noted at this point, that it is not possible for investors to diversify away all risk. The recent outbreak of the Coronavirus serves as a stark reminder that some world events impact all securities across territories. There are times such as the global financial crisis and the Coronavirus when there is 'nowhere to hide', except possibly in cash, which in the current low interest rate environment presents its own risks. These events are rare and in general one could accept that diversification as recommended by Markowitz (1952) is still a cornerstone of modern investing.

As will be evidenced below, there was a substantial interest by researchers during the late 1960s and early 1970s in the benefits of international diversification. Prominent, highly sighted research was conducted on this topic and almost all studies came to the same basic conclusion: there are significant benefits for investors who diversify internationally. Most of these studies found that higher risk adjusted returns were generated in global portfolios. This is true for both equity and bond markets. Eun, et al. (2012) argue that the deregulation of capital markets and the relaxation of foreign exchange regulations became commonplace in developed markets during the 1970s. This resulted in a steep growth in cross border investing and portfolios holding foreign investments were no longer uncommon (Eun, et al., 2012).

As mentioned, diversification became one of the cornerstones of modern investing. Early confirmation of this statement is Grubel (1968), who proposes that Markovitz's theory had by 1968 become the orthodox way of thinking about portfolio management. He points out that whilst diversification was by now regarded as a given in portfolio management, there have been no studies which explicitly test for the long-term benefits of international diversification. By testing the stock markets of eleven different countries (mostly developed countries and interestingly, South Africa) with static and dynamic models, he proved that the traditional ways of growing wealth (gains of trade and increase in production) were significantly enhanced when investors were able to diversify into internationally listed stocks.

As discussed in the introduction, risk and return are likely the two most important factors when constructing a portfolio. Grubel (1968) indicates through his model that in theory, it would have been possible for investors to increase their returns and simultaneously reduce their volatility.

Whilst it is only theoretical, it is worthy to note that an investor who was able to diversify into these international markets could potentially gain 12.6% at a volatility of 7.5% per annum, whereas the investor who could only invest on the New York Stock Exchange, would have had an upside cap of 7.5% at a volatility of 8.9%. The 5.1 percentage point difference resulted in a 68% higher rate of return. This was true even after exchange rate variables were accounted for (calculated on interest rate variables). This is a prominent study and of utmost importance (cited almost 2 000 times) has proven that international diversification benefits existed in both stock and bond markets for US investors (Grubel, 1968).

Prominent research on international diversification was conducted by Levy and Sarnat (1970). They built on the work done by Markowitz (1952) and agree that diversification of volatile assets could be an effective tool in managing risk, but only if a low correlation exists between the underlying assets. They postulate that when prices of underlying securities move together, no amount of diversification would help manage the risk in a portfolio that exclusively invests in those securities. They use the US industrial stocks from 1951 to 1967 as an example. This index positively correlated with both the railroad and public utilities indices during this period and consequently created few (if any) diversifying opportunities. Whilst not perfectly correlated, a strong enough correlation existed to minimise diversification opportunities among these industries (Levy & Sarnat, 1970).

Given this high correlation within the US stock market, they further theorise that there exist better diversification opportunities when a portfolio manager is willing to diversify internationally. Their paper set out to test if this was true for the period mentioned above. In a highly comprehensive study, they tested potential diversification opportunities between the US and 28 other countries. They made a painstaking effort to ensure that these countries were geographically diverse and included at least one country from every continent. A mixture of developed and emerging economies was included. Both equities and fixed interest instruments were modelled after the market equilibrium model of Lintner (1965) and Sharpe (1964). They found that there existed significant diversification opportunities, especially when emerging markets were included. The price movements among developed and emerging markets were at the time negligible and created a significant opportunity to improve risk adjusted returns. Contrarily, a country like Canada was found to correlate highly with the US (Levy & Sarnat, 1970). They concluded that “The Systematic nature of risk reduction through international diversification is reflected in the continuous reduction of the portfolio variance (at all levels of return) as the opportunity set is broadened. Thus, the best combination that can be created out of equities in the developing countries is a boot failure with a 5% return and a

26.5% standard deviation as compared with the return of 12% and standard deviation of 8% for the unconstrained optimum portfolio." (Levy & Sarnat, 1970, p. 673).

Another prominent study on international research that is recurrently found in literature on diversification is that of Solnik (1974). Fletcher, Paudyal and Santoso (2019) indicate that the research by Solnik (1974), alongside that of Grubel (1968), formed the foundation for many subsequent studies on international diversification. In this study, Solnik (1974) tested the opportunities for domestic as well as international diversification. He argues that the main reason for investors to diversify, as has been discussed, would not be to simply chase higher returns, but to mitigate the risk of the portfolio. He correctly indicates that the volatility in a portfolio will always be less than the sum of the underlying parts. Linear thinking about diversification suggests that the greater the number of holdings in a portfolio, the less risky the portfolio would be as the misfortunes of a single company would have limited impact. This thinking is only partially true as it would do little for risk management if the investor were holding securities that are not independent or uncorrelated. In his example, a portfolio of ten shares in a single sector would not mitigate the risk as well as ten shares from ten different sectors. He argues that risk management could further be accomplished when diversifying internationally and that this holds true (as is suggested in other studies) even when accounting for exchange rate differentials (Solnik, 1974).

To test the value of diversification, Grauer and Hakansson (1987) wrote a series of papers that studied the effect of diversifying portfolios by including non US assets. In their paper they used a multi-period portfolio model that consisted of all primary US asset classes, but they diversified the portfolios to contain underlying securities of 14 other countries. They made some findings that they themselves classified as surprising. Their first finding was that international diversification contributed significantly to returns for lower volatility portfolios (typically bonds and cash). This finding was so strong that they classified it as being "remarkably large" (Grauer & Hakansson, 1987, p. 722), proving that there are not only risk management benefits to diversification, but also benefits in investment returns. The second finding is of no use to this study and will not be discussed. Their final finding was, however, significant. They found that if portfolio managers in the US should diversify into international securities, there are many cases where the optimal holding of US securities were zero or close to zero. This confirmed what they initially hypothesised, which was that there exists strong market segmentation in the US. Considering that the USA was at the time the world's largest economy as it still is today, this is a significant finding as it proves that there is substantial value for the portfolio managers of such a large economy to diversify globally (Grauer & Hakansson, 1987).

As should be evident by now, there is a large body of literature on research conducted on the USA. It is worth reviewing literature from other geographic regions to compare the diversification results. Allen and Macdonald (1995) conducted a diversification study on equity markets from an Australian investor perspective. They also argue that globalisation may have diminished international diversifying opportunities and set out to test whether it minimised the diversification opportunities for the Australian investor. Their paper is of great value to this study as it will closely mirror their methodology to test for cointegration of Chinese government bonds. In their comprehensive study, Australian equities were compared to sixteen other global equity markets over a 22-year period (1970-1992). It is strategically valuable in choosing this period, since the 1970s was the time researchers really started to gain interest in diminishing global diversifying opportunities. Using the Engle-Granger and Johansen methods, they tested for long run cointegration. The Engle-Granger method revealed that international diversification opportunities existed in thirteen of the sixteen countries that they researched, with no clear long run comovements evident. The only exceptions were Hong Kong, Canada and the UK. The Johansen test gave slightly different results and found that cointegration existed between the German and Swiss equity markets (Allen & Macdonald, 1995). It is worthy to note at this point that it is possible to get differing results from the two different tests. For this reason, both methods will be included in this study as it will ensure more robust results.

This phenomenon of international investing initially gave investors a diversification opportunity, but researchers has since cautioned against the perceived notion that mere geographical diversification would translate into a diversified portfolio. Verspagen (1995) posits that as part of this globalisation movement, investors continually look to gain an advantage over the so called 'market'. Globalisation had implications for investors as diversifying opportunities became thinly spread. Elton and Gruber (1995) argue that the mere act of investing in international securities does not guarantee sufficient diversification, as international securities could mirror movements in the investor's home country. This would nullify the concept of international investing to mitigate potential investment risk. They suggest that investors who want to diversify internationally rather invest in countries where a low correlation in price movement exists.

In the immediate aftermath of the 2008 financial crisis, DiLellio (2009) researched diversification opportunities, and posed the question as to what should be done when traditional diversification opportunities fail, as they so spectacularly did in 2008. By then, globalisation was well established and when the markets came crashing down, there was

almost nowhere to hide. This then begs the question: is there really an effective way to diversify a portfolio in a globalised world? DiLellio asked: “In 2008, market events showed that some of the protection provided by diversification is lost when correlation among asset classes changes rapidly. Now, the question is: Are traditional diversification concepts no longer applicable due to some systemic change? Or is there still a simple, repeatable approach to diversification that can lead to significant protection against loss of principle?” (DiLellio, 2009, p. 1). He theorises that globalisation unequivocally contributed to the fact that asset movements were now more aligned than ever before. For instance, in the United States, bonds, stock market or interest rates changes have a ripple effect throughout the global economy. He indicates, for example, that the correlation between the S&P 500 and the MSCI EAFE (a large and middle market capitalisation equity index of 21 developed markets) increased from 0.54 in 1980, to 0.83 in 2009. This is a significant increase in the correlation between the US equity market and that of the rest of the developed world, clearly indicating that diversification opportunities have dwindled.

2.3 THE BOND MARKET

Along with equity markets, bond markets constitute the capital market. The most basic explanation of a bond would be a financial obligation by the issuer, to be paid to the holder on a specified date or dates in future. Bonds can be issued by different entities such as governments, municipalities, cities, private and public corporations (Fabozzi, 2006).

Research on bond markets is important for portfolio management, fiscal and monetary policy, long term forecasting, etc. Whilst equities are more frequently researched by academics, and storylines on equities often dominate news headlines by the mainstream media, bonds play a critical and often undervalued role in investments, economics and finance (Fabozzi, 2006). A country’s bond market is crucial to its financial system and a well-functioning bond market is one of the cornerstones of a fully functioning economy (Bai, et al., 2013; Belke, et al., 2017). During the 1990s, emerging markets became more prominent players in the local currency government bond markets. This was especially true in Asia, where local currency government bonds became important as an alternative financing vehicle to bank loans (Belke, et al., 2017).

Bonds and other fixed instruments were simple investment products before the 1980s. Investors bought these securities with the sole purpose of holding it to its maturity date and receiving the guaranteed interest (barring a default by the issuer). This changed in the early 1980s as fixed income products became rapidly more complex. Some products are so complex that it could be difficult to determine the exact interest and maturity date. Another

disruptive change in this market was that buying and holding to maturity, was replaced by traders who actively trade these instruments daily (Fabozzi, 2006).

Barth, et al. (2006) argue that the stability of an economy and positive real GDP growth per capita, from a microeconomic perspective, is reliant on a well-developed bond market. Using data from Standard and Poor, as well as the Bank for International Settlements, they indicate that countries which have higher levels of outstanding bonds relative to GDP, enjoy higher levels of real GDP per capita at a lower rate of volatility than countries which have lower levels of outstanding bonds. The relationship between outstanding bonds, real GDP per capita and lower volatility was significant. They refer to Alan Greenspan, former chairman of the US Federal Reserve, who called bond financing the "spare tyre" that assists an economy to better withstand economic downturns (Barth, et al., 2006). Today this is truer than ever, with governments primarily using bonds (via bond buying programs) as a medium to stimulate economic growth and recovery.

2.4 A GLOBAL FINANCIAL SYSTEM

The world has seen rapid globalisation in the last 70 years, post-World War Two. For example, the founding of the Eurozone and the European Single Market meant that the "four movements" of goods, services, capital and people were established. The implication of this was that capital, among other goods and services was able to travel across the boundaries of Europe without restriction, contributing to the phenomenon of globalisation as we know it today. A European Single Market effectively meant that capital could now flow freely between 28-member states of the EU and four non-member states, most of which are developed markets (Barnard, 2013).

Zimmermann, Drobetz and Oertmann (2003) support this view and indicate that, among others, the contributing factors to globalisation are: 1) Globalisation of economies within themselves; 2) The decreasing role of PPP and foreign exchange in Western economies; 3) The emergence of global trade systems, the decreasing of trading costs and forex exchange rates on international change; and 4) Increasingly available information. They confirm what others found in that:

> "Neglecting transaction costs and capital market imperfections, global portfolio decisions are determined by the risks and expected returns on national markets as well as global sectors. A first observation, well documented in numerous empirical studies, is that country-by-country correlations between global stock and bond market returns have substantially

> increased over the past decades. Alan Greenspan and Wall Street seem to be the leading indicators for what happens on The Global Economy and Investment Management the exchanges across the rest of the world (see Oertmann, 1997, for an interesting empirical study on this subject). This increase in correlations has dramatic effects on the risk of globally diversified portfolios. Global systematic risk has increased substantially" (Zimmermann, et al., 2003, p. 3)

Globalisation has undeniably caused greater integration between markets. This could partly be ascribed to looser market regulations that allow greater amounts of capital to flow between countries (DiLellio, 2009).

2.5 DIVERSIFICATION AND COINTEGRATION STUDIES ON BONDS

Understanding international bond linkages is important for researchers, investors and policy makers alike. Smith (2002), Yang (2005) and Ciner (2007) argue that effective global diversification of bonds could only be effected if the linkages and comovements thereof are understood, since bonds entail such a large portion of international investable assets. This section of the literature review will present a chronological account of studies conducted on this topic and will form the basis for the rest of the study.

2.5.1 The 1980s

By the late 1980s, a vast amount of research had been conducted on the international diversification of stocks. Many of these studies found that there were substantial benefits in terms of risk and volatility for investors to be internationally diversified. Levy and Lerman (1988) indicate that whilst this was true, much less research has been devoted to similar studies on bonds, despite the important role they play in a capitalistic system. In their study they focussed on three main issues: the first was to test whether international bonds could provide superior returns to bonds in the US; the second was to test if it was possible to build an international bond portfolio that could outperform US equities. The reasoning behind this test was that whilst stocks yielded superior risk adjusted returns in the 1960-1980s, the opposite was true in global markets, excluding the US. Thirdly, they set out to understand the general benefits of a US portfolio manager, who diversifies internationally, both in bonds and equities (Levy & Lerman, 1988).

They found that there existed a low correlation, not only among global bonds and the USA, but also among global bonds as a collective. This low correlation would have allowed investors, over this 20-year period, an opportunity to diversify their portfolios and achieve a

higher risk adjusted return. A significant finding in their paper was that for an investor with a US-based bond portfolio, it would have been more beneficial to diversify into international bonds, rather than into the US stock market. The correlation among international bonds was lower than the correlation between US bonds and the US stock market. The diversification benefit was so substantial that a US investor who diversified into international bonds would have received double the yield, at the same level of volatility (Levy & Lerman, 1988).

2.5.2 The 1990s

A pivotal paper to this study was that of Mills and Mills (1991). They indicate that various researchers in the 1960s and 1970s had found that there existed evidence to suggest that international stock markets were not highly interdependent and that there were opportunities to diversify internationally. As mentioned, by the early nineties researchers questioned whether this remained true concomitant with globalisation taking effect. Arguments were made that the findings of decades earlier perhaps did not hold true anymore as markets have become more integrated. By now, bad news events did not affect only the source and the domestic market but spilled over to other markets (Mills & Mills, 1991).

Mills and Mills (1991) built on studies of the time such as Baillie and Bollerslev (1989), who researched the global integration of exchange rates, and Eun and Shim (1989) who did the same for stock exchanges. Mills and Mills (1991) extended the research and tested the integration of international bond markets. They made use of daily close-of-trade prices from April 1986 to December 1989 for government bonds in West Germany, the US, the UK and Japan. They utilised the Engel-Granger test, Johansen test and impulse response function to test both the potential long and short run relationships. They found that the bonds of these countries, at the time, were not cointegrated and that their own domestic fundamentals and news were mainly responsible for changes in yields (Mills & Mills, 1991). This prominent paper by Mills and Mills (1991) provided excellent guidance to this study with regards to its methodology and variables. All the tests they conducted were incorporated in the methodology of this study.

By the early nineties the benefits of international diversification for bonds and equities were well documented. By the early mid-nineties investors took note and acted, as a rapid expansion of international bond buying by US investors was evident. In 1993, US investors were net purchasers of foreign bonds worth US$60 billion. As evidence of global expansion, US investors bought more bonds in this year, than in the entire preceding decade (Iben & Litterman, 1994). This phenomenon led researchers such as Iben and Litterman (1994) to question whether the benefits of international diversification had vaporised. They conducted a

study on international bonds of the G7 countries to test whether international diversification opportunities still existed. This study was similar to Levy and Lerman's (1988) and proved valuable, as a comparison could now be made six years later. Iben and Litterman (1994) found that international diversification opportunities still existed, but that correlations had increased, and yields moved closer together than in 1988. An interesting finding in their paper that is of interest to this study, was that Japan was the exception and had no increase in correlation (Iben & Litterman, 1994). One can possibly theorise that the geographical location of Japan, or the financial system of the East, made bonds of Far Eastern countries less integrated with the Western world.

2.5.3 Research at the turn of the century

By the early 2000s the trend of globalisation and world trade continued to increase. Equity and bond markets were an important source of liquidity and yet, research on international equities far outnumbered studies on international bonds. This, despite the international bond markets' superior market capitalisation (Barr & Priestley, 2004). Smith (2002) proposes that by now, market efficiency, equilibrium relations and international portfolio diversification were well documented in equity markets. Researchers have, for instance, found evidence of the January effect in equity markets (Gultekin & Gultekin, 1983), tested correlations (Solnik, et al., 1996) and long run cointegration (Kasa, 1992). Yet, there was still a gap in literature as to these hypotheses with relation to government bonds (Smith, 2002). Smith (2002) set out to close this research gap and conducted all the above mentioned techniques on government bonds, to ascertain whether a global diversification opportunity existed for bond investors. His study (as is the case in many others) focussed on developed countries (US, UK, Canada, Germany, Japan and France). Together they made up 85% of the world's bond market. His study made a significant finding: whilst comovements were decreasing in equity markets, bonds had the opposite effect. This suggested that there existed better opportunities in international bond diversification than in international equity diversification (Smith, 2002).

Another important paper that impacted this study, was submitted by McCauley and Jiang (2004). They found that larger bond markets which issued in greater volumes, had increased levels of trading which resulted in lower spreads. This could prompt investors to look to alternative markets as a diversification opportunity. They specifically tested Asian local currency bonds as a potential diversification opportunity for investors from the US, Europe, Australia and Japan. They found that the Asian markets did provide a diversification opportunity for investors in developed markets but cautioned that Asian bonds only provided a limited form of protection during a global bond market selloff. The level of protection was less than what they had anticipated (McCauley & Jiang, 2004).

European bond markets grew significantly after the European Monetary Union's establishment in 1999. Holder (1999) predicted that the size of government bonds for EMU members could be double that of the US by 2010. Against this backdrop, Yang (2005) examined the market linkages for European bonds between 1988 and 2003. This study will closely use the methodology used by Yang (2005), as will be discussed in more detail under the methodology section. He used the Granger causality to test for causal relationships and the Johansen cointegration method to test the potential long run relationship of bonds. He then used the forecast error variance decomposition to test short run relationships and potential economically statistical variables. He found no long run relationship between European bond markets and limited integration in the short run, arguing that European bond markets still provided diversification opportunities within themselves (Yang, 2005).

One of the first researchers to find that international diversification was subsiding, is Ciner (2007). He investigated the bond markets of the US, Japan, Germany and the UK between 1988 and 2005. Whilst he agreed with previous literature that identified diversification opportunities, he indicated that in the latter part of the dataset, increased cointegration was noticeable and that diversification internationally was perhaps not as significant any more as previously suggested (Ciner, 2007).

There are only a handful of studies that focus on emerging bond markets. Bunda, Hamann and Lall (2009) did a comprehensive study on the comovements of emerging government bond markets and set out to determine which local and international factors had the greatest influence thereon. They built a simple model that did not use any regression techniques, but rather opted for a correlation analysis over a rolling 60-day period. Their study stretched from March 1997 to October 2008, which was in the middle of the financial crisis. This is significant since certain observations with regards to emerging market bonds during the financial crisis could be made. The study is limited as there is no definitive information available on the after-crisis effects (Bunda, et al., 2009).

Importantly, they note that emerging market investors should expect periods of increased volatility that is unique to emerging markets. Examples of such events are the Tequila crisis (1994), the Asian Financial Crisis (1997), and the Argentine default (2001). Emerging markets are also sensitive to events in developed markets such as the September 11, 2001 attacks and the collapse of Lehman brothers in 2008 (Bunda, et al., 2009). Investors seeking diversification into these government bond markets should take these risks and volatility into account. As has been discussed, diversification is not about eliminating volatility and risk, but

to build a portfolio where comovements between underlying securities are limited. They made an interesting finding, in that government bonds of emerging markets had low correlations up to the financial crisis and thus created good diversification opportunities among themselves. As is discussed in the previous section, the financial crisis changed all of that and there was 'nowhere to hide'. Correlations among countries, as well as their credit spread, moved closer together during this time. Whilst diversification opportunities are evident, emerging markets are not spared when big global events affect all markets (Bunda, et al., 2009).

2.5.4 Recent cointegration studies

As mentioned, studies from the early eighties when the world became more globalised, started questioning the diversification opportunities within developed markets. Various studies have answered this question and have more recently found that international diversification, whilst in some cases less than before, still yielded good risk management results. A very recent paper, of great interest to this study was conducted in 2019 by Fletcher, Paudyal and Santoso. They set out to test whether international diversification was still possible within the G7 countries' government bonds. Some theorise that these countries have become so tightly integrated and offer limited diversification, should an investor choose to hold G7 countries government bonds in a single portfolio. They correctly indicate that it remained true that in 2019, most studies on international diversification focussed on the equity markets (Fletcher, et al., 2019).

Fletcher, et al. (2019) set out to close a gap in literature which at the time had not been addressed. They set out to test the G7 countries on longer term outstanding bonds (most studies use 10 year), inflation linked bonds and emerging market bonds. This identified gap in literature is important to this study as there remain, until recently, a shortage of studies on the diversification benefits of emerging market bonds (including China) to the developed markets. Using the Bayesian approach, they found that investing only in G7 bonds still had diversification benefits, but if short selling were illuminated, the diversification benefits were limited. They also found that there are significant diversification benefits when investing in international government bonds, especially when the bond portfolio consists of bonds from different regions in the world. An important finding in their study was, that whilst a portfolio consisting of different regions do offer significant diversification benefits, the diversification benefits vary significantly per region (Fletcher, et al., 2019).

This study will attempt to build on this research and determine the potential diversification opportunities that exist in China.

2.6 CHINA

Bonds are playing an increasingly important role in East Asian Economies. East Asia experienced unprecedented growth in the 1960s-1990s, known as the Asian Miracle. Secondary to government reforms that were the initial catalyst to this growth, firms had relatively easy access to capital in the form of bank loans (Barth, et al., 2006). With stable growth over three decades, this region was perceived as the "darling of foreign capital" (Reinhart & Rogof, 2009, p. 18) and was regarded as a region which practised a conservative foreign policy, high growth and savings rates with a stable currency and no recent history of financial crises (Reinhart & Rogof, 2009). Phumiwasana (2003) found that globally, economies with a higher dependence on banks, experienced higher levels of volatility and this held true in East Asia as well. When the Asian crisis of 1997 hit, this system of easy access to bank loans was exposed and "demonstrated that too great a reliance on banks may lead economies on a slower and more volatile path to prosperity" (Barth, et al., 2006, p. 11).

The Asian Crisis of 1997 led to a credit crunch as banks, which were now finding themselves in the midst of a debt crisis, cut back on lending in an effort to protect their balance sheets (Barth, et al., 2006; Reinhart & Rogof, 2009). Policy makers in these Asian counties had no choice but to intervene with financial reforms. Among these reforms to strengthen domestic financial policy, a conscious effort was made to establish and develop a more efficient domestic bond market. Barth, et al. (2006) propose that this intervention was successful and lead to bond markets in Asia becoming more efficient and an important source of financing (Barth, et al., 2006).

For decades, China self-isolated its economy from the world under communist rule (Fogel, 2008; Chow, 1993). This all changed in late 1978 and 1979 when Deng Xiaoping began what he called "reform and opening", today referred to by many as China's reform era (Kroeber, 2016). Economic reforms were adopted and China opened its borders to trade with the rest of the world. This in turn allowed the world to invest in its economy (Lin, 2011; Fogel, 2008). These reforms transformed the economy and China saw rapid economic expansion. GDP grew on average by 9% per annum between 1978 and 2002, "making China's economy one of the most dynamic in the world" (Fan & Chan-Kang, 2005, p. 1).

This rapid growth and economic reform changed the status of China from a country that barely had any global influence and little economic significance, into a global powerhouse. Despite being the most populous country in the world, China was only responsible for 1.8% of the world's GDP. Today that number has grown to 9.3%, making China the second largest global

economy after the USA. This has mostly been achieved by becoming the largest global exporter. China grew its exports from 0.8% of global exports to 9.6% (Lin, 2011). The relationship between their exporting and GDP growth is clear. This economic growth had a direct impact on Chinese wealth. By 1980, China was still relatively poor and had an income per capita that was a mere 30% of Sub Sahara Africa when measured on Purchase Power Parity (PPP). By 2011, China had on the same economic measure, three times the wealth per capita of Sub Sahara Africa (Lin, 2011). China was no different to other economies which experienced a reduction in poverty due to economic growth, but it also led to an increase in inequality (Fan & Chan-Kang, 2005).

Whilst an important catalyst, the reforms that the Chinese government implemented could not claim sole credit for the rapid economic growth. A tailwind that would aid Chinese growth was simultaneously developing in other parts of eastern Asia. From the middle 1960s rapid economic growth would become the norm in at least eight East Asian countries (Fogel, 2008). This unprecedented growth continued for the next three decades up to the Asian crisis of 1997 (Reinhart & Rogof, 2009; Pham, 2015; Fogel, 2008). Often described as the “Asian Miracle”, this regional economic expansion was, in part, due to the easy capital that firms were now able to access from banks (Barth, et al., 2006). This inevitably led to the banking crisis of 1997 (Reinhart & Rogof, 2009) but will not be discussed in this study.

Kroeber (2016) describes China as a “Bureaucratic-authoritarian one-party state, in principle highly centralised but in practice substantially decentralized” (Kroeber, 2016, p. 1). China has a unique political system as it is not a democracy like most Western economies, but it is also not a dictatorship that is ruled by a single leader. Despite continued communist rule, China's political system evolved remarkably differently to that of similar communist regimes. In stark contrast with countries like North Korea and Cuba, China evolved to have all power resting in the Communist Party as the ruling entity and not with an individual. The party oversees government functionality, military activity and presides over leaders being elected and restricted to term limits. This system ensures that major policy decisions are not being made by a single person, but by a group of senior leaders. Whilst not formally institutionalised, there remains a consistency in this practice. Another remarkable distinction between China and other communist regimes is that China, in its current state, successfully transferred power between three unrelated living leaders (Kroeber, 2016).

With China and the rest of East Asia becoming more prominent players in the world economy, various studies among their capital markets and developed markets have been conducted. In an important paper for this study, Cheng and Glascock (2005) examined the linkage between

mainland China, Hong Kong and Taiwan's (Greater China Economic Area) stock markets with the United States and Japan, using GARCH and ARIMA models. They argue that this region draws increasing attention from international investors as they are becoming more prominent players on the world investment stage. They set out to determine if the Greater China Economic Area's stock exchanges were following the globalisation trend by becoming more cointegrated, with greater comovements. They specifically researched this to determine if there existed cross country diversification opportunities, or whether that diminished along with globalisation. They indicate that at the time, research had been done on this topic, but it focused mainly on the so-called Asian Tiger countries (Hong Kong, Singapore, South Korea and Taiwan). They specifically wanted to test the Greater China Economic area since there was a research gap. They found that the GCEA stock markets were not cointegrated with Japanese or the US stock markets and that nonlinear relationships between the US and GCEA were weak. They suggest that, despite the increasing globalisation trends, a good diversification opportunity still existed in Asian markets for US portfolio managers (Cheng & Glascock, 2005). This study will build on their work to determine if the same is true for Chinese government bonds.

Using correlation analysis and GARCH, Piljak (2013) found that over the period of 2000 to 2011, China's government bonds had a strong positive correlation with its counterparts in the USA at 0.761. He further found that Chinese bonds reacted like US bonds when changes occurred on a macroeconomic level. This is an interesting finding as China gave limited access to international investors during this time. He found that emerging markets as a group offered a good diversification opportunity to US investors, but during this time, China on its own, offered only limited diversification opportunities for those who were able to access this market (Piljak, 2013). Of interest to this study is to test how this has changed now that international investors are able to invest freely in China. This study will determine if these developments brought China even closer to international counterparts, especially in developed markets and to determine if it created diversity to such an extent that it created more attractive diversification opportunities for international investors.

Bai, et al. (2013) indicate that the bond markets of the developed world have been well researched, but that emerging markets have been neglected. Despite China becoming the world's second largest economy, relatively few studies on its bond market have been conducted. This is surprising since the value of China's bond market is large in relative terms and by 2013, was the third largest market behind the US and Japan. The shortage in research could potentially be explained by the inability of international investors to access the Chinese bond market, or the subdued trading in the secondary market. By 2013, daily prices for bonds

were not available to investors, bringing into question the liquidity and efficiency of the market (Bai, et al., 2013).

This was still true as recently as 2015. Pham (2015) advances that China's government bond market was, despite its size, relatively underdeveloped when compared to global bond markets. He ascribes this to the fact that the Chinese government is ignorant of fundamental macroeconomic conditions, thus hampering the proper development of their bond market. He tested the Chinese 10-year government bond yields against eight fundamental macroeconomic variables and found that all but one (foreign participation), had insignificant influence on bond prices. Pham (2015) further theorises that if China were able to constitute an effective bond market, it would have various positive implications. Firstly, it would open China's doors to access more international capital at competitive costs, leading to lower borrowing rates. Secondly, a properly functioning global bond market will enhance the overall financial system and finally, a properly functioning bond market will serve as a useful indicator of future market expectations (Pham, 2015).

Since the global financial crisis in 2008, many central banks started a quantitative easing programme that essentially means "printing money" and buying bonds from the government. This is done in an attempt to add liquidity and stimulate the economy. Another measure attempting to stimulate the economy is to keep interest rates at what is now known as historical lows. Low interest rates have inevitably led to low bond rates and governments can hence borrow at lower costs. This phenomenon is very evident in every developed market today but has not fully rolled over to emerging markets. The success of these bond buying programmes is still debated by academics (Belke, et al., 2017).

In their 2017 study, Belke, et al. set out to test what the influence of these historical low bond yields was on emerging markets in Asia. This paper is of importance for this study, as it indicates whether changes in developed markets long-term bond yields, spilled over to Asian markets. One of the important findings in their study was that emerging markets benefitted from the historical low yields of developed market bonds due to emerging markets rendering higher yields. Many emerging markets did not only offer higher yields, but better risk adjusted returns (Belke, et al., 2017). This assisted emerging markets in attracting significant foreign inflow of capital. (Belke, et al., 2017; Agur, et al., 2019). In fact, the biggest contributor to emerging market foreign direct investments since the early nineties was government bonds (Bunda, et al., 2009).

Belke, et al., (2017) found that changes in Japanese policy, such as its quantitative easing programme which started in April 2013, had an influence on Chinese bonds. However, this event contrasted the change in Bank of Japan's governor, which affected other Asian markets but not China. They conclude that only some events in Japan had a significant long-term effect on Chinese bonds. Unsurprisingly, they also found that the changes in the US bond market had increasingly significant effects on the Chinese bond market, intensifying with every new announcement of a quantitative easing programme in America. A long-term spill over effect was evident, as well as a reaction to short term shocks. This has significant implications for this study as it displays limited diversifying opportunities for US investors. Finally, they found that European bonds had event-driven impacts on China, but not a consistent influence. The European crises of 2010 impacted Indian and other Asian bonds but had no effect on China. On the other hand, the "Whatever it takes" speech in 2012 by Mario Draghi, the president of the European Central Bank indicated a longer-term effect on China. Their general finding on China is that certain events in the developed markets influenced Chinese government bonds, but that there has not been consistency of influence. This could prove that diversification opportunities do exist. One would not expect different markets to be completely disconnected from one another, but sporadic disconnection could create good diversification opportunities.

2.7 SUMMARY

This chapter set out to review literature relevant to this study, fulfilling the requirement set out in chapter one. Whilst the study is primarily about Chinese government bonds, a wider array of literature had to be reviewed as important elements from the broader field of finance need to be understood in order to place the findings of this study in context.

In chapter two, studies on diversification were firstly reviewed to place the study in context. The main aim of this study is to determine the potential diversification opportunities that Chinese government bonds could offer. Before making a finding, it is important to understand how diversification is tested for and what previous findings on diversification there have been. Markowitz's portfolio theory was a logical starting point as many other studies refer to it and start at this point. From there, other prominent researchers such as Grubel, as well as Levy and Sarnat were discussed. Many studies found that diversification as Markowitz described, was a good principle and had positive effects on investment portfolios. No studies could be found that proved the contrary. Research that was done on international diversification all indicate that there are benefits in diversifying internationally, instead of diversifying only locally.

After diversification, the bond market in its wider context was reviewed. This helped to contextualise the importance of bond markets in a well-developed, modern economy. It also identified potential gaps in bond market research that this study could close. It was evident that no diversification study on China, nor the variables opted for in this study have yet been conducted.

Thereafter, another fundamentally important principle to this study, globalisation, was reviewed. This section is important as it ties in with diversification. It was found that studies conclude that the globalised world has offered less diversification, concomitant with the unfolding of global development. This fact is important, as an alternative diversification opportunity in China could be found.

In the fifth section, two of the topics that were reviewed were now combined. Diversification and cointegration, specifically on bond markets, were reviewed. This indicated two important outcomes. The first was to understand how similar studies were conducted and which methodologies were used. This study will build on those methodologies and findings. Secondly, it assisted in showing that this particular research has not yet been conducted and that a gap in the literature exists.

In the conclusion of this chapter, research done on China was reviewed. As with the previous section, this had two important outcomes: the first was to place China and its unique regime and financial system into context; and secondly, to understand the extent to which the country and its financial system, especially bonds has been examined. It was found that little research has been done on Chinese bonds and that there exists an opportunity for this study in closing this gap.

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Chapter 3 Research methodology

3.1 INTRODUCTION

In chapter two, the theoretical framework for this study was discussed in detail. A variety of research methods was used to study interlinking and co-movements of bond and equity markets. These ranged from ARIMA models to different cointegration methods, and in many instances even a simple correlation analysis. This study used these research papers to decide on the best methodology that would be suitable to test for potential diversification opportunities between Chinese government bond markets and five developed bond markets. This chapter will discuss the methodology opted for and will describe how the research questions developed in chapter one, will systematically be answered.

The chapter will start with the research design which will give a broad overview of the analytical framework. This will be followed by a short discussion of the research method used. A detailed discussion on the different research instruments and their respective formulae will follow, to show which research instruments in previous studies were deemed relevant and what their function will be in this study. As this is a quantitative study, a detailed discussion on the data and variables will indicate how data was gathered and explain the reasoning behind opting for independent variables. Finally, a short conclusion will be drawn at the end of the chapter.

3.2 RESEARCH DESIGN

According to Quinlan (2011), there are four stages in the data analysis process: description, interpretation, conclusion and theorisation. This study will broadly follow this logical process to draw conclusions from the data.

As globalisation reduced international diversification opportunities, a need arose for investors to explore alternative markets to diversify international bond and equity portfolios. This study will test whether China, which recently opened its government bond market to international investors, could potentially offer investors in developed bond markets such an opportunity. This will be done by conducting a variety of tests and analyses including correlation analysis, causality testing, cointegration and short run relationships. Should the correlation be high and causality, cointegration or short run relationships be evident, limited diversification

opportunities would exist. If there is no, or limited evidence that such relationships exists, diversification could be possible. This concept is, among others, confirmed by studies such as that of Levy and Sarnat (1970), Levy and Lerman (1988), Mills and Mills (1991), Allen and Macdonald (1995), Elton and Gruber (1995), Smith (2002) and DiLellio (2009), who all used a combination of the methodologies mentioned to reach conclusions on diversification possibilities for equity and bond markets.

Quinlan (2011) describes the research process as one whereby data is gathered and analysed to explore or establish a phenomenon. This phenomenon is then analysed by using either quantitative or qualitative data. This study opted for a quantitative approach as bond yield data is freely available, accurate and measurable. As is presented in the literature review, numerous similar studies also employed a quantitative method. In quantitative research, computer software is often used to identify underlying patterns or statistical relationships. These are then used to make measurements and observations by the researcher (Quinlan, 2011). This study will follow that research method and make use of EViews 10 computer software to build the various models to be discussed. The results from these models will then be used to make certain inferences and conclusions.

The main outcome of most research is to generate new theory. New theory is developed by reading literature on a given topic to determine where there may be research gaps. Data is then analysed and a new theory within the greater theoretical framework is developed (Quinlan, 2011). This study will attempt to do the same. As is evident in the literature review, there are no studies that test for diversification opportunities between the Chinese government bond market and developed government bond markets.

3.3 RESEARCH METHOD

A systematic process will be followed in which the following will be done: a preliminary analysis, which will include a correlation analysis and Granger Causality test. Before cointegration testing can commence, it is important to test for unit roots according to Brooks (2014) and therefore, two tests, the Augmented Dickey Fuller and Phillips-Perron tests will be used to test for it. Cointegration testing will then commence with the Engle-Granger two-step method (a bivariate method) and the Johansen cointegration test (a multivariate method based on a vector autoregression). The Johansen cointegration tests will consist of two parts. Firstly, pairwise testing will be done to test for cointegration between China and all the individual developed bond markets. A multivariate test will follow, which will determine if cointegration exists among any of the other markets. Finally, two innovation accounting techniques, the

impulse response function and variance decomposition will be conducted to test for short run relationships.

3.4 RESEARCH INSTRUMENTS

3.4.1 Correlation analysis

A correlation analysis is a simple technique whereby the strength of the relationship between two variables is determined. This is done by mathematically calculating the correlation coefficient between them. The result can assist in making certain predictions about a time series. The correlation coefficient of two variables is always expressed as a number between -1.0 and +1.0. A correlation coefficient of -1.0 means that two variables have a perfect negative relationship, whereas a correlation coefficient of +1.0 indicates a perfect positive relationship. A correlation coefficient of 0 indicates that no determinable correlation exists. When the correlation coefficient is ≤ -0.7 or > 0.7, it is deemed a strong correlation (Wegner, 2007).

As evidenced in the literature review, a vast number of studies such as that of Levy and Sarnat (1970), Elton and Gruber (1995), DiLellio (2009) and Eun, et al. (2012), used this simple technique to determine whether potential international diversification opportunities exist. The basic assumption is that if two asset classes have a weak correlation, diversification between them is possible (Levy & Sarnat, 1970; Smith, 2002). In this study, a high correlation between two bond markets would lead one to believe that limited diversification opportunities exist, as changes in one bond market would affect the other bond markets and become an accurate predictor of potential movements for the second bond market (Smith, 2002).

Some of the reviewed studies made exclusive use of correlation analysis. This seems to have been a popular research method before more sophisticated methodologies such as causality and cointegration analysis were developed. None of the more recent studies relied exclusively on a correlation analysis. Despite newer techniques, recent studies still used correlation analysis as part of a complete set of tests and should increase the robustness of the findings.

The correlation analysis serves a second purpose as it creates comparable results to prior studies, thus giving insight into how some global dynamics have changed over the decades. As is true with many of the other tests to be discussed further on, the results of this test should not be interpreted in isolation.

3.4.2 Granger causality test

This test was developed by the Nobel Prize winner in Economics, Clive Granger. In his breakthrough paper of 1969, he set out to determine whether it was possible to understand the relationship between two variables and if data from one variable, that has a causal relationship with another, could assist in explaining the other variable. He argues that "[i]t is shown that in the two-variable case the feedback mechanism can be broken down into two causal relations and that the cross spectrum can be considered as the sum of two cross spectra, each closely connected with one of the causations" (Granger, 1969, p. 424).

To test for causality among the variables, this study will use the Granger causality test. This tests the correlation between the current value of a variable against the past value of the others (Brooks, 2014). This will assist in determining if causality is present, and if it is, what the directionality is thereof (Borozan, 2011). "The argument follows that if y_1 causes y_2, lags of y_1 should be significant in equation for y_2. If this is the case and not *vice versa*, it would be said that y_1 'Granger-causes' y_2…" (Brooks, 2014:335). This explains a one-directional causality from y_1 to y_2. "On the other hand, if y_2 causes y_1, lags of y_2 should be significant in the equation for y_1" (Brooks, 2014:335). The formula that is used to determine this is:

$$\boldsymbol{X(t) = \sum_{r=1}^{L} A_r X\,(t - r) + \varepsilon_t} \qquad (1)$$

One could also have a case where both sets of lags are significant. In such a case one can conclude that there exists what Brooks (2014) calls a 'bi-directional' causality, meaning there is a causality between two variables that interchangeably influence each another. If there exists no statistical significance between the two variables, one can accept that they function independent from each other (Brooks, 2014). This test will be an early indication of potential causal relationships which is useful when interpreted alongside cointegration tests and innovation accounting. This method was used in studies such as that of Yang (2005) and Borozan (2011).

3.4.3 Unit root tests

Allen and Macdonald (1995) submit that the first step in testing for cointegration is to test for stationarity. Cheng and Glascock (2005) argue that "cointegration requires that variables be integrated of the same order" (Cheng & Glascock, 2005, p. 350) and should therefore be tested for a unit root before any cointegration tests can be conducted. Brooks (2014) posits that it is important to treat stationary and non-stationary data differently. When testing for

cointegration it is necessary to test all data for stationarity, as it has to be nonstationary at I(0) but stationary at I(1).

In this study two tests will be conducted to test for stationarity. The first will be the Augmented Dickey-Fuller (ADF) test. This test was developed by Dickey and Fuller in 1979, in what is considered to be pioneering work in the field of testing for a unit root in a time series (Brooks, 2014) and remains the most popular test for stationarity (Allen & Macdonald, 1995). According to Brooks (2014) they developed the following formula:

$$\boldsymbol{y_t = \phi y_{t-1} + \mu_t} \qquad (2)$$

The objective of this formula is to test whether $\phi = 1$ against the alternative of $\phi < 1$.

Brooks (2014) indicates that the ADF test does not perform well when there are structural breaks in the data and therefore it has been ensured that in this study there is none.

The second test to be conducted will be the Phillips-Perron (PP) test. Brooks (2014) advances that Phillips and Perron developed a more holistic unit root theory. Whilst the PP test is similar to the ADF test, it "incorporate[s] an automatic correction to the DF procedure to allow for autocorrelated residuals" (Brooks, 2014, p. 364). Their test often yields the same results as ADF, but unfortunately does not overcome the basic limitations of ADF. Despite this, it offers an alternative test for stationarity and will be conducted to ensure results are robust. This is important since unit root testing plays a fundamental role in cointegration tests. This is true for both the Engle-Granger and Johansen tests. The formula used by the PP test is presented as (Leybourne & Newbold, 1999):

$$\boldsymbol{y_t = \alpha + p y_{t-1} + \mu_t} \qquad (3)$$

Allen and MacDonald (1995), as well as Mills and Mills (1991) used the ADF test to determine whether the data they used was stationary. In studies such as Cheng and Glascock (2005), the PP method was opted for, whilst Yang (2005) made use of both methods to test for a unit root and stationarity. This study makes use of both unit root tests to align itself with Yang (2005) and to ensure the results are robust.

3.4.4 Engle Granger two-step method

Brooks (2014) theorises that when data is non-stationary and thought potentially to be cointegrated, there are three possible methods to test for cointegration. These are the Engle-Granger method, Engle-Yoo method and the Johansen cointegration test. In this study, the

Engle-Granger method and the Johansen cointegration tests will be conducted to test for cointegration. This is aligned with similar bond studies such as Allen and Macdonald (1995) and Yang (2005), who used both these cointegration tests to test for long run relationships. Brooks (2014) proposes that the Johansen test is a superior test, but Yang (2005) reasons that, whilst the Johansen test is used more often in similar studies, the Engle-Granger test is a good test to enhance the robustness of the results. It has therefore been included in this study.

The first cointegration test will thus be the Engle-Granger two-step method, a bivariate (Allen & Macdonald, 1995), single equitation technique (Brooks, 2014). As the name suggests it consists of two basic steps. The first is to run a regression using the ordinary least squares (OLS) method (Brooks, 2014). The formula for this regression according to Allen and Macdonald (1995) is:

$$\boldsymbol{X_t = \alpha + \beta Y_t + \mu_t} \qquad (4)$$

The residuals of this time series are then saved and the second step is conducted, which is to test the residuals for a unit root. In this study only the ADF will be used to test for unit roots as part of the Engle-Granger method. If the residuals contain a unit root, the variables are not cointegrated. If they do not contain a unit root, they are cointegrated (Allen & Macdonald, 1995).

3.4.5 Vector autoregression model (VAR)

Before the second cointegration test (Johansen test) is conducted, a vector autoregressive model (VAR) should be constructed as it forms the basis on which the Johansen test is built (Allen & Macdonald, 1995). Brooks (2014) indicates that a VAR is a regression model but differs from univariate models in that more than one dependant variable exist. A VAR model is a popular econometric tool that is flexible, gives ease of generalisation and its notation could be expressed more easily than would otherwise be the case with large simultaneous equations being notarised (Brooks, 2014; Kocenda & Cerny, 2015). The standard VAR equation according to Brooks (2014) can be expressed as:

$$\boldsymbol{y_t = A_0 + A_1 y_{t-1} + e_t} \qquad (5)$$

Brooks (2014) purports that a VAR model is a useful tool in determining short run relationships among bond markets and whether a lead-lag relationship exists among the variables. To determine this relationship, an optimal lag length needs to be determined, as an inappropriate lag length could skew the results (Brooks, 2014; Smith, 2002). Brooks (2014) argues that

"[o]ften, financial theory will have little to say on what is an appropriate lag length for VAR and how long changes in the variables should take to work through the system." (Brooks, 2014, p. 330). The choice of the correct lag length is thus important, as a lag length that is too short could lead to serial correlation problems, whilst a lag length that is too long could lead to a diminished sample size (Hall, 1991). In a study like this with a relatively short time series, the latter could potentially be problematic. To overcome this potential difficulty in the model, information criteria will be used to determine the correct lag length, for instance, as done by Yang (2005).

3.4.6 Johansen cointegration test

This test was developed by Professor Soren Johansen in 1988 and his frequently cited paper (more than 23 000 times), developed the idea of taking a nonstationary series to test for cointegration. Johansen improved on earlier cointegration models by developing a system whereby multiple cointegrating relationships could be observed (Johansen, 1988). This test revolves around the Π -matrix, also known as the long run coefficient matrix (Brooks, 2014). It is based on the VAR and differs from the Engle-Granger method since it can provide estimates of all the potential cointegrating vectors that may be present (Allen & Macdonald, 1995).

The Johansen method can best be described as a maximum likelihood method that centres around the Π -matrix as mentioned above (Allen & Macdonald, 1995). Maggiora and Skerman (2009) describe it as "a maximum likelihood method that determines the number of cointegrating vectors in a non-stationary time series vector autoregression (VAR) with restrictions imposed, known as a vector error correction model (VECM)" (Maggiora & Skerman, 2009, p. 18). Mills and Mills (1991) assert that this test can be used to test how many of the vectors in the system are linearly independent.

The formula used by this model according to Maggiora and Skerman (2009) and Brooks (2014) is:

$$\boldsymbol{\Delta X_t = \mu + \sum_{i=1}^{n} r_i \Delta X_{t-1} + \alpha \beta\, X_{t-1} + \epsilon_t} \qquad (6)$$

where:

X_t – The vector of all non-stationary indices

r_i – Matrix of coefficients

α – Matrix of error correction coefficients

β – Matrix of cointegrating vectors (Maggiora & Skerman, 2009)

The same formula will be used in this study. The formula above is analysed for two test statistics called the Trace test and Maximum Eigenvalue test (Kocenda & Cerny, 2015; Smith, 2002; Yang, 2005). Both tests are used frequently in econometric studies (Lutkepohl, et al., 2002). Their respective formulae are:

$$\boldsymbol{\lambda_{trace}}(\boldsymbol{r}) = -\boldsymbol{T}\sum_{\boldsymbol{i=r+1}}^{\boldsymbol{N}} \boldsymbol{ln}(\boldsymbol{1}-\boldsymbol{\lambda_i}) \qquad (7)$$

$$\boldsymbol{\lambda_{max}}(\boldsymbol{r}+\boldsymbol{1}) = -\boldsymbol{T}\,\boldsymbol{ln}(\boldsymbol{1}-\boldsymbol{\lambda_{r+1}}) \qquad (8)$$

where:

r – Number of cointegrating vectors

λ_i – Estimated value of the Eigenvalue from the Π matrix

"λ_{trace} is a joint test where the null is that the number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r. It starts with *p* eigenvalues, and then successively the largest is removed" (Brooks, 2014, p. 387). Yang (2005) confirms the null hypothesis for this test by stating: "The null hypothesis for the trace test is that there are at most *r*(0≤ r < *p*) cointegrating vectors" (Yang, 2005, p. 601).

"λ_{max} conducts separate tests on each eigenvalue and has as its null hypothesis that the number of cointegrating vectors is r against an alternative of $r + 1$" (Brooks, 2014, p. 387).

It can be accepted that no cointegration exists if none of the above (trace or max) statistics are greater than their critical values (Brooks, 2014).

3.4.7 Vector error correction model (VECM)

When cointegrating vectors are present in the VAR, the vector error correction model (VECM) is used to model short run relationships by adjusting to short run changes (Andrei & Andrei, 2015). According to Brooks (2014), a VECM is used as part of the VAR to assist the simultaneous modelling of long and short run relationships. The main principle in VECMs is that there exist long run relationships among variables, they could sometimes be out of equilibrium in the short run (Min, 2019).

The VECM will only be used if cointegration is evident in the Johansen cointegration test, using the formula (Lutkepohl, et al., 2002):

$$\Delta xt = \Pi x_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta x_{t-j} + \varepsilon_t \qquad (9)$$

If the Johansen cointegration test finds that no cointegration is present, then the VAR as discussed above will be used for the impulse response and variance decomposition tests to follow (Smith, 2002). However, the VAR should be restated to the first difference and not level as for the Johansen test (Yang, 2005).

3.4.8 Impulse response function

Brooks (2014) holds that whilst a VAR is helpful in determining the variables with a statistically significant impact on the future values of each variable (via examination of causality), it cannot explain the sign (positive of negative effect) of the impact, nor how long it would take for the change in variables to work through the system. To obtain that information an impulse response function and a variance decomposition should be conducted. "Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks of each of the variables" (Brooks, 2014, p. 336). This means that a 'unit shock' is applied to all the errors of each of the variables in the equation, after which the effects over time are observed (Min, 2019; Brooks, 2014; Mills & Mills, 1991). This is affected practically by changing the VAR to a vector moving average (VMA). Brooks (2014) indicates that the standard deviation of a dependent variable is observed to determine the effect of a one standard deviation change in another variable (Brooks, 2014; Borozan, 2011). If a shock is administered to the system, it should gradually fade if there exists stability in the system (Brooks, 2014).

3.4.9 Variance decomposition

Variance decomposition is a classical statistical method, often used in studies as alternative simulations equation models and assists in simplifying large sets of data by simplifying the structures (Lütkepohl, 2010). They are also useful in assisting with the interpretation of the results found in the Granger causality test. Whereas the Granger causality test indicates direction, the variance decomposition offers insights into the strength of the causal relationship (if any) (Yang, 2005). Brooks (2014) suggests that a variance decomposition is similar to impulse response tests but uses an alternative measuring tool. The main difference between variance decomposition and impulse response functions is whereas impulse response functions observe the difference in variables in relation to other variables, variance decomposition observes the movements due to its 'own' shocks, instead of shocks to other variables. 'Own' shocks in a VAR is often the best explanatory indicator of errors in the series (Brooks, 2014; Sims, 1980).

Belke, et al. (2017) used this in their study on the spillover effect of international bonds to emerging Asian economies. They confirm the use of the model to test variables for shocks within its own systems. In their study, they used a generalised VAR framework. This method allowed them to observe the variance decompositions that are consistent with the ordering choice. The use of the generalised approach used in their study, further allowed observation of correlated shocks. These shocks consider the error distribution created by the variables (Belke, et al., 2017). This is done by taking the positive residuals and applying one standard deviation to each of the equations (Sims, 1980; Borozan, 2011).

The ordering of the variables becomes an important consideration when conducting the impulse response function and variance decomposition. This is because impulse response only tests the shock on one equation in the VAR, whilst assuming all the other equations remain constant and are completely independent of one another. Yet this could be incorrect as there would likely exist a correlation in the errors of the different equations. To overcome this, an orthogonalized impulse response is generated, implying that the order of the variables is determined (from most exogenous to most endogenous) before an impulse response is generated to ensure statistical independence. This is achieved through tests such as the Wald Block Exogeneity (Brooks, 2014).

In this study, the Chinese government bonds will be tested for short run relationships against the developed markets. If they do not react in the same way as the other developed markets do to one another, it can be assumed that a shock in the developed market, affecting other developed markets, will not affect China in the same way. This will be an indication that Chinese government bonds do offer a diversification opportunity for developed bond market investors. Yang (2005) summarises the result of the test by stating "…variance decomposition reveals to what extent variation of a certain economic variable can be explained by innovations from other economic variables in the system. It can be used to measure the relative importance of other economic variables in influencing a particular economic variable" (Yang, 2005, p. 602). Should the test find that the developed bond markets do not have a relative influence on Chinese bond markets, one could accept that diversification opportunities exist.

3.5 DATA

As can be deduced from Table 3:1, the data used in this study was sourced from Bloomberg, a reliable source for investors and researchers alike. The most recent data in this dataset was compared to various other sources of current bond information, such as the world government

bond website. The data in the dataset proved to be valid and accurate and is deemed a reliable data source for this study.

Table 3:1: Summary of Government Bond Data

Country	Variable	Bond size rank	GDP size rank	Source
Australia	10 Year Government Bond Yields	11th	14th	Bloomberg
China	10 Year Government Bond Yields	3rd	2nd	Bloomberg
Germany	10 Year Government Bond Yields	6th	5th	Bloomberg
Japan	10 Year Government Bond Yields	2nd	3rd	Bloomberg
UK	10 Year Government Bond Yields	7th	4th	Bloomberg
USA	10 Year Government Bond Yields	1st	1st	Bloomberg

Source: Bloomberg & FTSE Russell

The population for this study is all developed countries that issue government bonds globally. No emerging markets have been considered as this study will focus specifically on China as an alternative to developed bond markets. A selection had to be made and the following countries were included: China is the first inclusion as it will be the bond market which is being tested and is hence the dependent variable. As far as the independent variables are concerned, the first two inclusions are the United States and Japan as they are, according to the FSTE Russel World Government Bond Index (FTSE Russel Group, 2020), currently the world's two biggest bond markets, comprising approximately 37% and 19% respectively of the world's bond market. This would align the study to the work of Cheng and Glascock (2005) whose work was an important building block to this study. They tested the linkages between the Greater China Economic Area's stock markets against that of the US and Japan. Two other prominent studies that significantly influenced this study in terms of concept and methodology were those of Mills and Mills (1991) and Smith (2002), who both included the US and Japan.

The next two inclusions are the sixth and seventh largest bond markets in the world, that of the UK and Germany. This is to align the study further with the prominent study on international bond diversification, that of Mills and Mills (1991), which included the UK and Germany. Smith (2002) also used Germany and the UK but differed from Mills and Mills (1991) by including Canada and France. Whilst Italy and France had marginally larger bond market capitalisations at the time of writing, they could fluctuate as bonds mature and issue and are not nearly as

popular in similar studies as the UK and Germany. This study opted rather for Germany and the UK as they are still highly ranked in outstanding bonds; are used more frequently in studies on bonds; and are currently the fourth and fifth biggest economies by GDP in 2020 (World Population Review, 2020). This selection would result in the fact that the study is aligned with two prominent studies on international bonds despite the omission of France, Italy and Canada.

Finally, Australia has been selected to bring this study in line with an important study done by McCauley and Jiang (2004), who tested Australian, US, Japanese and European bonds against Asian local currency bonds for potential diversification. As this study will focus on China, it was deemed relevant to use Australia as the results could be compared to that of McCauley and Jiang (2004) and include at least one country that is not part of Europe or North America.

Data frequency in studies on international bond linkages differ greatly. Studies such as Mills and Mills (1991) and Ciner (2007) made use of daily data. Skintzi and Refenes (2006), Cappiello, et al. (2006) used weekly data and studies such as Smith (2002) and Yang (2005) used monthly data. Cheng and Glascock (2005) also made use of weekly data on their stock exchange study. Other studies even made use of annual data. The nature of this study and the effect of globalisation, call for higher frequency data as higher frequency data will be conductive to better capturing the potential diversification effects amidst globalisation (Mills & Mills, 1991). Monthly and annual data will thus not suffice and therefore weekly data was selected. Daily data would be ideal, but due to the international nature of this study, markets are never all open at the same time. To address this challenge, weekly data will be used over a period of 2017-2020. Cappielo, et al. (2006) argue that using weekly data helps to overcome non-synchronous trading issues. The maturity date for bond yields have been chosen as the 10-year bond yield. This is a popular measurement and has been used in many studies such as that of Pham (2015) and Belke, et al. (2017).

3.6 SUMMARY

This chapter set out to give a detailed account of the methodology to be used in this study. The chosen method was based on similar studies done on bond markets, focussing on studies that used cointegration to identify potential diversification opportunities.

A research method was developed and discussed, after which each of the specific research instruments to be used was explained. This study will be of a quantitative nature, whereby the

ten-year bond yields on the government bonds of China are tested against Australia, Germany, Japan, the UK and the USA for potential diversification opportunities. To determine this, a systematic approach will be taken and various research instruments will be used.

For preliminary testing, a correlation analysis and the Granger causality test will be conducted. Thereafter, unit root testing in the form of the Augmented Dickey Fuller and Phillips-Perron tests will be conducted to test the data for their stationarity. Thereafter, a vector autoregression will be constructed to assist in the cointegration tests to follow. The Engle-Granger two-step method (bivariate) and Johansen cointegration tests (multivariate) will be used to test for potential long run relationships among variables. Finally, two innovation accounting techniques will be used to understand the impact that shocks in one variable may have on the other variables. In the data section, the variables and frequency opted for were explained in detail.

This chapter will assist the reader in understanding the systematic approach that was taken to come to the conclusions made later in the study. It will also assist future researchers, who want to build on the findings, to understand the exact methodology elected.

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Chapter 4 Results and Findings

4.1 INTRODUCTION

This chapter will implement the analytical framework discussed in chapter three to answer the research questions set out in chapter one. The chapter will be structured as follows: firstly, a correlation analysis will be done. This will be followed by the Granger causality test, which will indicate if there is evidence of causality among the bond markets. Before the cointegration tests can be done, the Augmented Dickey Fuller and Phillips-Perron tests will be conducted to test for unit roots to determine the stationarity of the data. Cointegration analysis will then commence, led by the Engle-Granger two-step method, followed by the vector autoregression model (VAR), which will form the foundation for the Johansen cointegration analysis. Finally, to test for short run relationships and shocks to the errors of the models, innovation accounting will be done utilising impulse response functions and variance decompositions.

The results will be analysed together, not only as individual tests with individual outcomes. The combined results and outcomes of the analysis will give a clear indication of whether cointegration exists and whether diversification may be possible.

4.2 DATA

The data used in this study is weekly, ten-year government bond yields of China, Australia, Germany, Japan, the UK and the USA. A detailed reasoning for these specific variables, their frequency and timeline is provided in the data section in chapter three. The data only goes back to 2017, since this is when the Chinese government bond market was opened to investors, and ends in March 2020. The government bond yields of all countries used in this study are provided in Figure 4:1.

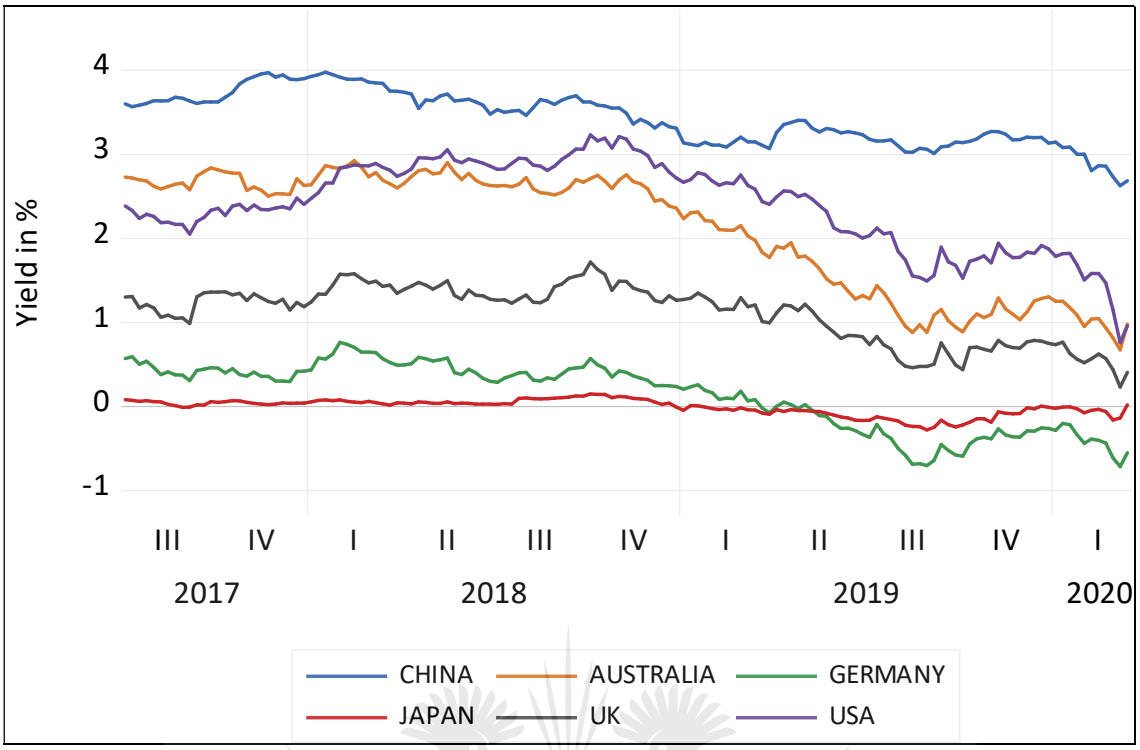

Figure 4:1: Annual government bond yields since 2017
Source: Bloomberg

Two general observations can be made when assessing the bond yields graphically. The first is that there has been a general downward trend in all bond yields. China has not reacted differently to the rest of the markets. One can also observe that Chinese bonds follow a general direction relative to the developed bond markets. However, it is not immediately clear, when considering the above if there exist significant relationships among these markets, and therefore specific tests should be conducted.

4.3 CORRELATION ANALYSIS

Since the development of more sophisticated tests like those presented later in this chapter, correlation studies by themselves have become uncommon. Yet they remain evident in some studies such as Smith (2002), DiLellio (2009) and Eun, et al. (2012). All these studies indicate that correlation will give an early indication of potential diversification. A correlation analysis was run, and the results are provided in Table 4:1

Table 4:1: Correlation analysis

	CHINA	AUSTRALIA	GERMANY	JAPAN	UK	USA
CHINA	1.0000	0.8392	0.8495	0.6716	0.7690	0.6215
AUSTRALIA	0.8392	1.0000	0.9815	0.8495	0.9387	0.8397
GERMANY	0.8495	0.9815	1.0000	0.8718	0.9475	0.8322
JAPAN	0.6716	0.8495	0.8718	1.0000	0.8366	0.7391
UK	0.7690	0.9387	0.9475	0.8366	1.0000	0.9302
USA	0.6215	0.8397	0.8322	0.7391	0.9302	1.0000

Source: EViews 10

The correlation analysis indicates that there exists mostly strong (> 0.7 according to Wegner (2007)) correlations among all bond markets, except between China and Japan, which is < 0.7 but still moderately strong. The results in Table 4:1 suggest that China has a lower correlation with Japan, the UK and the USA when compared to other developed bond markets.

At first glance it may seem that all these bond markets are so strongly correlated, that little diversification opportunities exist. In fact, when considering the methodology deployed by studies such as Levy and Sarnat (1970) and Levy and Lerman (1988) one could argue that they would have come to that exact conclusion. Levy and Lerman (1988), for instance, make a strong argument that diversification is only possible when low correlation exists. That theory still seems to hold true and this study will not attempt to argue otherwise as it could find no evidence to the contrary. However, there is a large array of literature, with very little dispute, that global assets in most asset classes have moved much closer together in the age of globalisation. As was discussed in the literature review, studies such as Iben and Litterman (1994) already found that developed bond market correlations moved closer together than what was found in their 1988 study. Bunda, et al. (2009) found that since the turn of the century, developing market bond yields were also starting to correlate more strongly with developed market bonds. DiLellio (2009) confirmed this theory with his research in the aftermath of the 2008 financial crisis.

For the reasons given above, the correlation analysis should never be interpreted alone and therefore other tests to supplement findings will now be conducted.

4.4 UNIT ROOT TESTING

According to Allen and McDonald (1995), unit root testing should be done on the time series before cointegration analysis can commence. Mills and Mills (1991) and Cheng and Glascock (2005) confirm that unit root testing is the first step in a cointegration study. Brooks (2014) submits that for cointegration tests to be performed, each time series should be tested and confirmed to be non-stationary at I(0) and stationary at I(1).

To test for stationarity, two separate unit root tests were done as is the case in Yang (2005): The Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The ADF is the most popular test for stationarity (Allen & Macdonald, 1995). The null hypothesis in this test states that the series contains a unit root and is thus non-stationary. The alternative hypothesis is then that the series does not contain a unit root and is stationary (Yang, 2005). For the sake of completeness, a second unit root test was conducted to determine if the findings are aligned with the ADF test. The results of these tests are summarised in Table 4:2

Table 4:2: Unit root tests

	ADF		PP	
	I(0)	**I(1)**	**I(0)**	**I(1)**
China	0.9763	0.0000***	0.3496	0.0000***
Australia	0.6049	0.0000***	0.6390	0.0000***
Germany	0.5468	0.0000***	0.5219	0.0000***
Japan	0.5569	0.0000***	0.6325	0.0000***
UK	0.4797	0.0000***	0.5533	0.0000***
USA	0.9727	0.0000***	0.9727	0.0000***

*, **, ***, Indicates significance on a 90%, 95% and 99% confidence intervals

Source: EViews 10

In both tests, the p-value of all the bond markets for the level data, I(0), indicated acceptance of the null hypothesis at the 95% confidence level. This confirms that all series contain a unit root and is non-stationary on I(0). Furthermore, the p-values of each of the six bond markets on I(1) indicated the rejection of null hypothesis. This implies that these series do not contain a unit root, confirming that all series are stationary on I(1). This finding indicates that the data is suitable for cointegration tests (Brooks, 2014).

4.5 GRANGER CAUSALITY TEST

As the name suggests, the Granger causality test indicates whether causality exists among variables. In other words, do changes in one variable cause a change in another variable? This test was used in studies such as that of Yang (2005) and Borozan (2011). Yang (2005) argue that the Granger causality test is a useful test to determine provisionally if short run relationships are present. Should one variable cause a change in another variable, the lags or subsequent observations in the first variable could be significant in the equation of the second variable. The same holds true if the scenario is flipped around: if a change in the second variable is responsible for a change in the first variable, the lags of the second variable will be significant in the equation of the first variable (Brooks, 2014).

The above could be applied to the relevant bond markets in this study. If changes in the yields of one bond market, causes changes to the yields in another bond market, it can be assumed that there exists a unidirectional causality. Changes in one variable influence the other variable and could potentially explain future changes in the said variable. It could also happen that both bond markets simultaneously affect changes in the other. Should that happen, it can be concluded that there exists a bi-directional causality, suggesting that each of the two bond markets under observation, is responsible for changes in the other (Brooks, 2014).

For potential diversification opportunities to exist, there should be little or no causality between two bond markets as this will mean they move independently from one another (Brooks, 2014). The null hypothesis in the Granger causality test is that one variable does not cause changes in the other variable (Borozan, 2011). To reject the null hypotheses, thus proving that there is a causal relationship between the variables, a 95% confidence interval will be used. The results of the Granger causality test, run on differenced data are illustrated in Table 4:3.

Table 4:3: Granger causality test

Null Hypothesis:	Observations	F-Stat	Probability
AUSTRALIA does not Granger Cause CHINA	138	0.69979	0.4985
CHINA does not Granger Cause AUSTRALIA		0.10054	0.9044
GERMANY does not Granger Cause CHINA	138	0.95467	0.3876
CHINA does not Granger Cause GERMANY		0.26245	0.7696
JAPAN does not Granger Cause CHINA	138	2.51755	0.0845*
CHINA does not Granger Cause JAPAN		0.73304	0.4824
UK does not Granger Cause CHINA	138	0.39673	0.6733
CHINA does not Granger Cause UK		0.07759	0.9254
USA does not Granger Cause CHINA	138	0.86855	0.4219
CHINA does not Granger Cause USA		0.02500	0.9753

*, **, ***, Indicates significance on 90%, 95% and 99% confidence intervals

Source: EViews 10

The Granger causality test reveals that when Chinese bonds are compared to the other bond markets, there are none of the null hypotheses that can be rejected at a 95% confidence level. There is only a single unidirectional causal relationship, whereby changes in Japan can cause changes in China. Even this can only be rejected at a 90% confidence level. From the results above, it should be clear that there does not exist prominent causal relationships between China and the developed market bonds. This is an early indicator that there are no significant short run relationships and therefore, potential diversification opportunities could exist.

Yang (2005), who conducted a similar study, argues that at this point, these results should only be interpreted as preliminary results and assessed alongside the cointegration tests that will follow. He gives two reasons for his reasoning: the first is that “strong contemporaneous correlations between market innovations are not yet taken into consideration” (Yang, 2005, p. 607). Hence, a VAR and cointegration test should also be done as is the case below. The second is that this test only provides insight into the potential statistical relationships, but not necessarily the economic relationships (Yang, 2005). A variance decomposition to be concluded later later will assist in this regard

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4.6 ENGLE-GRANGER TWO-STEP METHOD

Cheng and Glascock (2005) confirm the importance of cointegration tests in their postulation that integration will exist across borders if underlying asset classes are priced the same. Assets are deemed to be integrated if they tend to move together in the long term. Should these markets be too tightly integrated, it could create a limited diversification opportunity (Cheng & Glascock, 2005; Allen & Macdonald, 1995; Mills & Mills, 1991). Rigorous tests for cointegration are thus essential to determine potential diversification opportunities. This will give an indication of whether there are long run co-movements present between Chinese government bonds and the developed government bond markets.

As the name explains, the analysis consists of two steps. The first step is to run a regression on the two variables and save their residuals. In this study, China is the dependent variable and has therefore been tested against each of the independent variables. This analysis is done on level data. The second step is to conduct a unit root test on the residual series. Neither the trend nor the intercept was included in the equation as it is a test on the residuals. As is discussed in detail above, the null hypothesis of the ADF test (that was used to test the residuals for a unit root) is that the series contains a unit root. If the null is rejected, it would mean that the series does not contain a unit root and indicates that cointegration is present. Should this be the case, a further step, an ECM (error correction model) is built. If the coefficient thereof is negative and significant, it implies there is movement back to equilibrium when short term shocks occur, with the coefficient indicating how quickly the move occurs (Allen & Macdonald, 1995). The results of the residual ADF unit root test is provided in Table 4:4

Table 4:4: Results of Engle-Granger two-step method - ADF residual stats

	t-Statistic	Probability
Australia	-1.6212	0.0988
Germany	-1.9639	0.0477**
Japan	-0.3644	0.5518
UK	-1.9703	0.0470**
USA	-1.3047	0.1767

** Indicates rejection of the null hypothesis on a 95% confidence level
Source: EViews 10

The results in Table 4:4 indicate that there are three single equations in Australia, Japan and the USA, where the null hypothesis can be accepted on a 95% confidence level. In these equations, a unit root is present and therefore no cointegration is present. In the cases of

Germany and the UK the null hypothesis can be rejected on a 95% confidence level and does not contain a unit root. For both these cases an ECM was built and the results are summarised in Table 4:5.

Table 4:5 ECM results

	Coefficient	Probability
Germany	-0.0211	0.4558
UK	-0.0096	0.6797

Source: EViews 10

In both ECM's results, it is evident that the coefficient is negative – leading to convergence towards the long-run equilibrium. However, the coefficients are not significant (not < .05). In both instances the move back to the equilibrium is very slow (between 0.1% and 0.2% correction in each period). This might explain the insignificance of the coefficients.

The Engle Granger (bi-variate) analysis confirms that no cointegration is present between Chinese government bonds and that of Australia, Japan or the US. Cointegration is present between China-Germany and China-UK although the convergence toward equilibrium is insignificantly slow.

Whilst helpful in making the results of a study more robust, the Engle Granger two step method presents a couple of shortcomings. Firstly, as only two variables are tested against each other, there could potentially exist more than one cointegrating relationship. Secondly, it is not possible to determine cointegration or cointegrating relationships in the first step in the process. No hypothesis testing can therefore be conducted, and a second step needs to be done (Brooks, 2014). Finally, there can also be what Brooks (2014) calls "simultaneous equations bias". This becomes an issue if there is bidirectional influence between the two variables that are being tested. Since only one variable could be tested at a time (one dependent and one independent), this could lead to incomplete results. To overcome problem number one, the Johansen pairwise will be conducted as it tests bidirectionally. To overcome problem number two and three a VAR, testing multiple variables, will be built and the Johansen cointegration test will then be run thereon (Brooks, 2014).

4.7 VECTOR AUTOREGRESSION MODEL (VAR)

Before the Johansen cointegration multivariate analysis can be done, a vector autoregressive model (VAR) needs to be constructed on level data, as it forms the foundation for the Johansen test (Brooks, 2014; Yang, 2005).

Brooks (2014), Yang (2005) and Hall (1991) indicate that one of the potential obstacles in VAR modelling is to choose the correct lag length. Lags refer to the value that a variable had in a previous period and becomes an important concept in testing for cointegration, as changes in one variable could take time to influence another variable (Brooks, 2014). For example, in this study it could mean that a change in Chinese bond yields could take a couple of periods to have an influence on the bond yields of other countries and vice versa. Consequently, to test for cointegration, it is necessary to allow the VAR to test for relationships across lagged time periods. The selection of the correct lag length is critical in this process, as a lag length that is too short could cause an oversight in potential comovements. A lag length that is too long could skew the findings in the model (Hall, 1991).

Brooks (2014) submits that one of the difficulties in lag length selection criteria, is that financial theory gives little guidance on what the ideal lag length should be. This is partly due to a lack of consensus on how long changes in a variable should take to work through the system. The full theory of lag lengths falls outside of the scope of this study, so it would suffice to say that Brooks (2014) indicates that information criteria are the best way to estimate the ideal lag length. The information criteria used to determine the optimal lag length will be: Akaike, Schwartz and Hannan-Quinn information criteria.

Table 4:6: VAR lag length selection criteria

Lags	Akaiki	Schwartz	Hannan-Quinn
0	-6.8239	-6.6935	-6.7710
1	-19.7255*	-18.8128*	-19.3546*
2	-19.6316	-17.9365	-18.9428
3	-19.4313	-16.9538	-18.4245
4	-19.3133	-16.0535	-17.9887
5	-19.2058	-15.1637	-17.5632
6	-18.8657	-14.0412	-16.9052
7	-18.6327	-13.0258	-16.3543
8	-18.5365	-12.1473	-15.9401

* Indicates lag order selected by the criterion

Source: EViews 10

Table 4:6, indicates that a one lag length structure will be best suited for the VAR. All three of the different information criteria indicated the same result and will hence be accepted and used as the ideal lag length. The VAR was run on level data with a one lag length criterion and the results are encapsulated in Table 4:7.

Table 4:7: Vector autoregression (VAR) on one lag length

	CHINA	AUSTRALIA	GERMANY	JAPAN	UK	USA
CHINA(-1)	0.9706	0.0546	0.0699	-0.0045	0.0643	0.0881
	-0.0308	-0.0482	-0.0359	-0.0164	-0.0464	-0.0535
	[31.5548]	[1.1334]	[1.9463]	[-0.2733]	[1.3865]	[1.6463]
AUSTRALIA(-1)	0.0765	1.0130	0.1083	0.0307	0.1065	0.0962
	-0.0358	-0.0561	-0.0418	-0.0191	-0.0540	-0.0623
	[2.1366]	[18.0600]	[2.5906]	[1.6064]	[1.9702]	[1.5448]
GERMANY(-1)	-0.0834	0.0260	0.7768	-0.0333	-0.0783	-0.1728
	-0.0795	-0.1245	-0.0928	-0.0425	-0.1199	-0.1382
	[-1.0488]	[0.2090]	[8.3738]	[-0.7849]	[-0.6528]	[-1.2499]
JAPAN(-1)	-0.0966	-0.0537	0.0439	0.9303	-0.0012	-0.1492
	-0.1071	-0.1677	-0.1250	-0.0572	-0.1616	-0.1863
	[-0.9019]	[-0.3202]	[0.3515]	[16.2636]	[-0.0074]	[-0.8011]
UK(-1)	0.0516	-0.0542	-0.0071	0.0187	0.7524	0.0782
	-0.0717	-0.1123	-0.0837	-0.0383	-0.1082	-0.1247
	[0.7191]	[-0.4825]	[-0.0847]	[0.4883]	[6.9545]	[0.6270]
USA(-1)	-0.0438	-0.0295	-0.0228	-0.0243	0.0444	0.9517
	-0.0287	-0.0450	-0.0335	-0.0154	-0.0434	-0.0500
	[-1.5234]	[-0.6562]	[-0.6790]	[-1.5829]	[1.0232]	[19.0402]
C	-0.0090	-0.1000	-0.3836	-0.0084	-0.2722	-0.4653
	-0.1286	-0.2013	-0.1501	-0.0687	-0.1940	-0.2236
	[-0.0701]	[-0.4965]	[-2.5562]	[-0.1230]	[-1.4032]	[-2.0809]

Source: EViews 10

Note: First line is coefficient, second line is standard errors and [ ] is t-statistics

4.8 JOHANSEN COINTEGRATION TEST

Earlier in this study it is mentioned that the Engle-Granger method was used to consider the bi-variate case. The Johansen cointegration tests will now be effected as the second cointegration analysis. These may well be the most important tests in this study as they are used in all prominent bond market diversification studies such that of Allen and Macdonald (1995), Mills and Mills (1991), Smith (2002) and Yang (2005).

Brooks (2014) show that the Johansen cointegration test consists of two separate tests. The first is the λ_{trace} test which is a joint test, whereby the null hypothesis states that the "number

of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than one r" (Brooks, 2014, p. 387). Should the null be rejected at a 95% confidence level, it can be accepted that cointegration is present. Should the null be accepted, no cointegration is present in any of the equations (Yang, 2005). The second test, the λ_{max} is a separate test on each of the Eigenvalues and its null hypothesis is "that the number of cointegrating vectors is *r* against an alternative of *r* + 1" (Brooks, 2014, p. 387).

Two different methods will be used (the λ_{trace} and λ_{max} will be used in both) to determine if cointegration is present. The first will be the Johansen pairwise tests, where China will individually be tested against each of the individual bond markets. Thereafter, a multivariate Johansen test will be conducted to test for cointegration among all the markets.

4.8.1 Johansen pairwise tests

As discussed, the Johansen pairwise test will test for cointegration between China and each of the individual markets. The results of China against all the developed markets λ_{trace} test are given in Table 4:8.

Table 4:8 Pairwise Johansen cointegration test (Trace)

Variable	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Probability
Australia	None	0.0408	6.0213	15.4947	0.6930
	At most 1	0.0017	0.2300	3.8415	0.6315
Germany	None	0.0598	8.5931	15.4947	0.4043
	At most 1	0.0002	0.0217	3.8415	0.8828
Japan	None	0.0367	5.2656	15.4947	0.7800
	At most 1	0.0005	0.0750	3.8415	0.7842
UK	None	0.0465	6.6336	15.4947	0.6206
	At most 1	0.0001	0.0108	3.8415	0.9169
US	None	0.0660	10.0183	15.4947	0.2793
	At most 1	0.0038	0.5242	3.8415	0.4690

Source: EViews 10

The results of the λ_{trace} test indicate that there are no pairwise equations where the null hypothesis can be rejected at a 90%, 95% or 99% confidence level. The alternative hypothesis is thus accepted and confirms that there is no cointegration present between China and any of the developed bond markets. The λ_{max} test was also conducted, and the results are summarised below in Table 4:9.

Table 4:9 Pairwise Johansen cointegration test (Max Eigenvalue)

Variable	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value	Probability
Australia	**None**	0.0408	5.7913	14.2646	0.6402
	At most 1	0.0017	0.2300	3.8415	0.6315
Germany	**None**	0.0598	8.5714	14.2646	0.3236
	At most 1	0.0002	0.0217	3.8415	0.8828
Japan	**None**	0.0367	5.1906	14.2646	0.7176
	At most 1	0.0005	0.0750	3.8415	0.7842
UK	**None**	0.0465	6.6228	14.2646	0.5347
	At most 1	0.0001	0.0108	3.8415	0.9169
US	**None**	0.0660	9.4941	14.2646	0.2473
	At most 1	0.0038	0.5242	3.8415	0.4690

Source: EViews 10

As is the case in the λ_{trace} test, the results of the λ_{max} test indicate that there are no pairwise equations where the null hypothesis can be rejected at a 90%, 95% or 99% confidence level. The alternative hypothesis is thus accepted and confirms that there is no cointegration present between China and any of the developed bond markets.

4.8.2 Johansen multivariate tests

Now that the pairwise test has been concluded, a multivariate test will be run on all the bond markets to see if cointegration is present. The Johansen cointegration λ_{trace} test was conducted on all the markets, based on the complete VAR, and the results are presented in Table 4:10.

Table 4:10: Multivariate Johansen cointegration test (Trace)

No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Probability
None	0.2430	91.2409	95.7537	0.0982
At most 1	0.1210	52.5446	69.8189	0.5253
At most 2	0.1090	34.6169	47.8561	0.4684
At most 3	0.0831	18.5709	29.7971	0.5241
At most 4	0.0364	6.5063	15.4947	0.6357
At most 5	0.0097	1.3561	3.8415	0.2442

Source: EViews 10

The results indicate that none of the equations can be rejected at a 95% confidence level. This indicates that the null can be accepted and that there is no cointegration present. The λ_{max} test was also conducted, and the results are given in Table 4:11.

Table 4:11: Multivariate Johansen cointegration test (Max Eigenvalue*)*

No. of CE(s)	Eigenvalue	Max -Eigen Statistic	Critical Value	Probability
None	0.2429	38.6962	40.0775	0.0710
At most 1	0.1210	17.9277	33.8768	0.8812
At most 2	0.1090	16.0460	27.5843	0.6619
At most 3	0.0831	12.0646	21.1316	0.5413
At most 4	0.0363	5.1501	14.2646	0.7228
At most 5	0.0097	1.3561	3.8414	0.2442

Source: EViews 10

The results support those found in the λ_{trace} and indicate that there are none of the equations that can be rejected at a 95% confidence level. This indicates that the null can be accepted and that no cointegration is present.

Both cointegration tests, on the pairwise and multivariate, conclude that no long run co-movements are present between China and any of the bond markets. The fact that no cointegration is present confirms that diversification opportunities do exist (Allen & Macdonald, 1995; Yang, 2005; Smith, 2002).

4.9 IMPULSE RESPONSE FUNCTION

Brooks (2014) asserts that the examination of a VAR clarifies underlying comovements and whether variables have an influence on the future values of other variables. Whilst useful in determining long run relationships, these models have two shortcomings: the first is that they cannot determine the sign of the relationship; in other words, if there will be a positive or a negative impact. The second is that they cannot determine the duration of the impact and how long that impact will take to work through the system. Both shortcomings can be overcome by conducting an impulse response function and variance decomposition on the VAR (Brooks, 2014).

Before an impulse response function or variance decomposition can be conducted, the ordering of the variables should be determined because the outcome is sensitive to the order (Brooks, 2014; Mills & Mills, 1991). A VAR on differenced data was constructed, from which the Block Exogeneity Wald test was done. This test assists in determining the correct ordering for the impulse response function and variance decomposition. The Block Exogeneity Wald test has a null hypothesis that states that the dependent variable is exogenous. Therefore, if a variable has a joint probability of less than .05 the null hypothesis can be rejected, and the

variable is endogenous. If the joint probability is larger than .05, the null hypothesis can be accepted, and the variable is exogenous (Brooks, 2014). The results are provided in Table 4:12.

Table 4:12: Block Exogeneity Wald test

Variable	Joint Probability	Order
China	0.6763	1st
Australia	0.2672	4th
Germany	0.2784	3rd
Japan	0.2569	5th
UK	0.4521	2nd
US	0.0796*	6th

*,**,***, Indicates significance on a 90, 95 and 99% confidence level respectively

Source: EViews 10

The Block Exogeneity Wald Test indicates that all the bond markets have a joint probability of larger than 0.05. This implies that the null hypothesis can be accepted and that all these variables are weakly exogenous. As can further be concluded from the table above, the correct ordering of the variables has been determined and the Cholesky ordering will be as follows: China, UK, Germany, Australia, Japan and finally the US. Now that the correct ordering has been determined, the impulse response function can be done.

Eun and Shim (1989) argue that if a shock to one variable does not lead to effects in subsequent variables later in the system, the said variable is mostly independent from the variable which was shocked and is determined by its own fundamentals in the short run. Should all systems return to normal, it indicates that markets are efficient and limited arbitrage opportunities exist (Mills & Mills, 1991). Ahmad, et al. (2012) give valuable insight to the reaction of variables. They indicate that if one variable reacts differently to shocks when compared to the others, it is likely driven by its own fundamentals and could indicate potential short-term diversification opportuniies. This fact will become an important interpretation tool in the discussions below.

The results of the impulse response function and the interpretation of their results will be illustrated in figures 1-5 on the pages to follow.

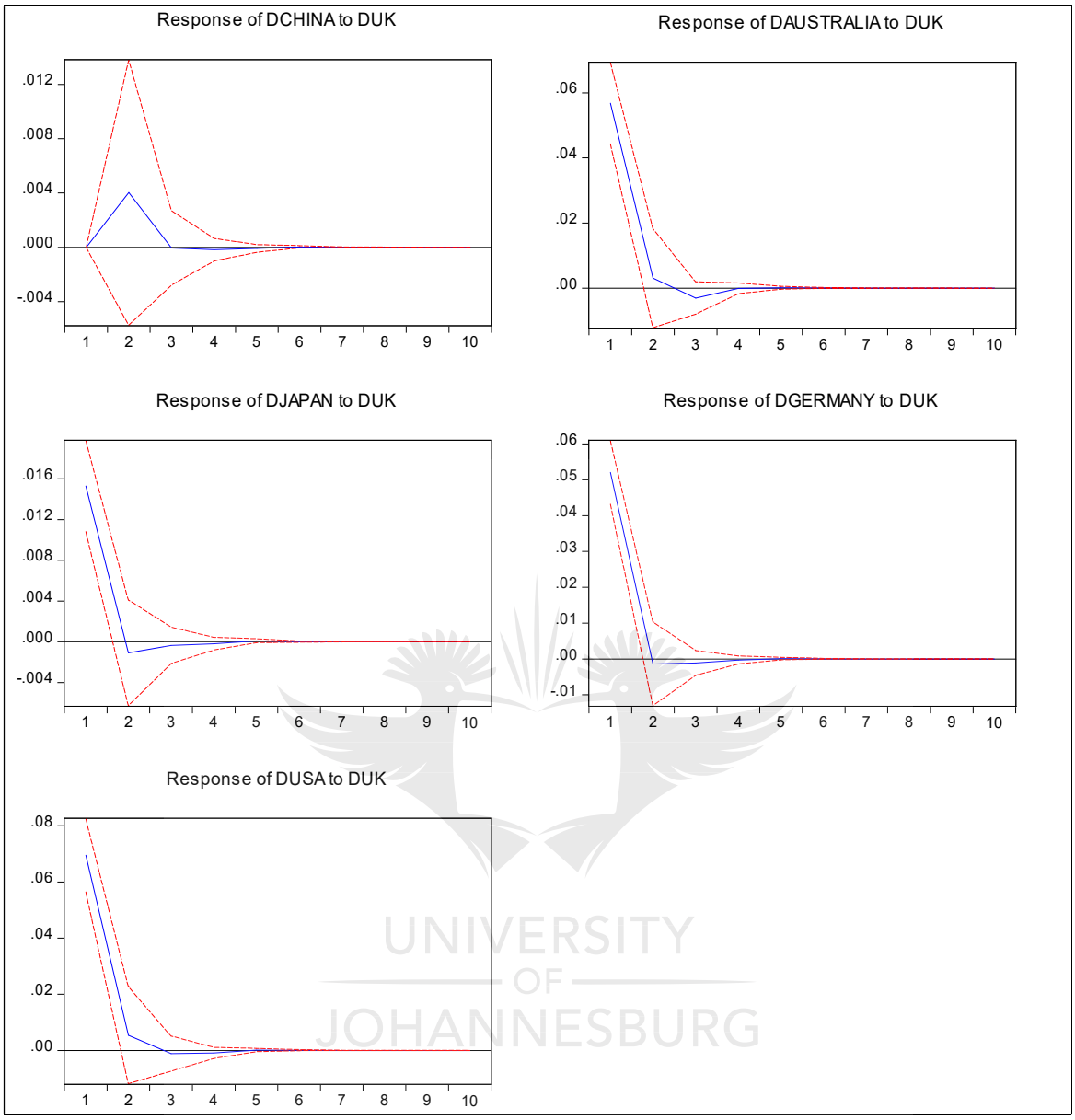

Figure 4:2: Impulse Response Function: Shock to the UK bond market

Source:EViews 10

4.9.1 Analysis of a shock to the UK bond market

The Chinese market did not react to a shock in the UK bond market in the first period. It had a 0.004 standard deviation reaction in the second period and then recovered fully by the third period, with no further shocks.

Unlike the Chinese bond market, all the other markets reacted with an immediate positive shock,only differing in magnitudes. Japan had the largest reaction at 0.15, followed by the US at 0.07, Australia with just under 0.06 and Germany just over 0.05. Most of them faded by the second period, with Australia and the US experiencing very small positive shocks and Japan and Germany, very small negative shocks. By the fourth period they had all returned to normal with no further shocks.

The results of a shock in the UK bond market indicate that the Chinese bond market could potentially offer a diversification opportunity as it shows a distinctly different reaction to a shock, compared to the others. All the other markets reacted in a similar way, with China being the sole exception, clearly indicating a diversification opportunity against the other markets.

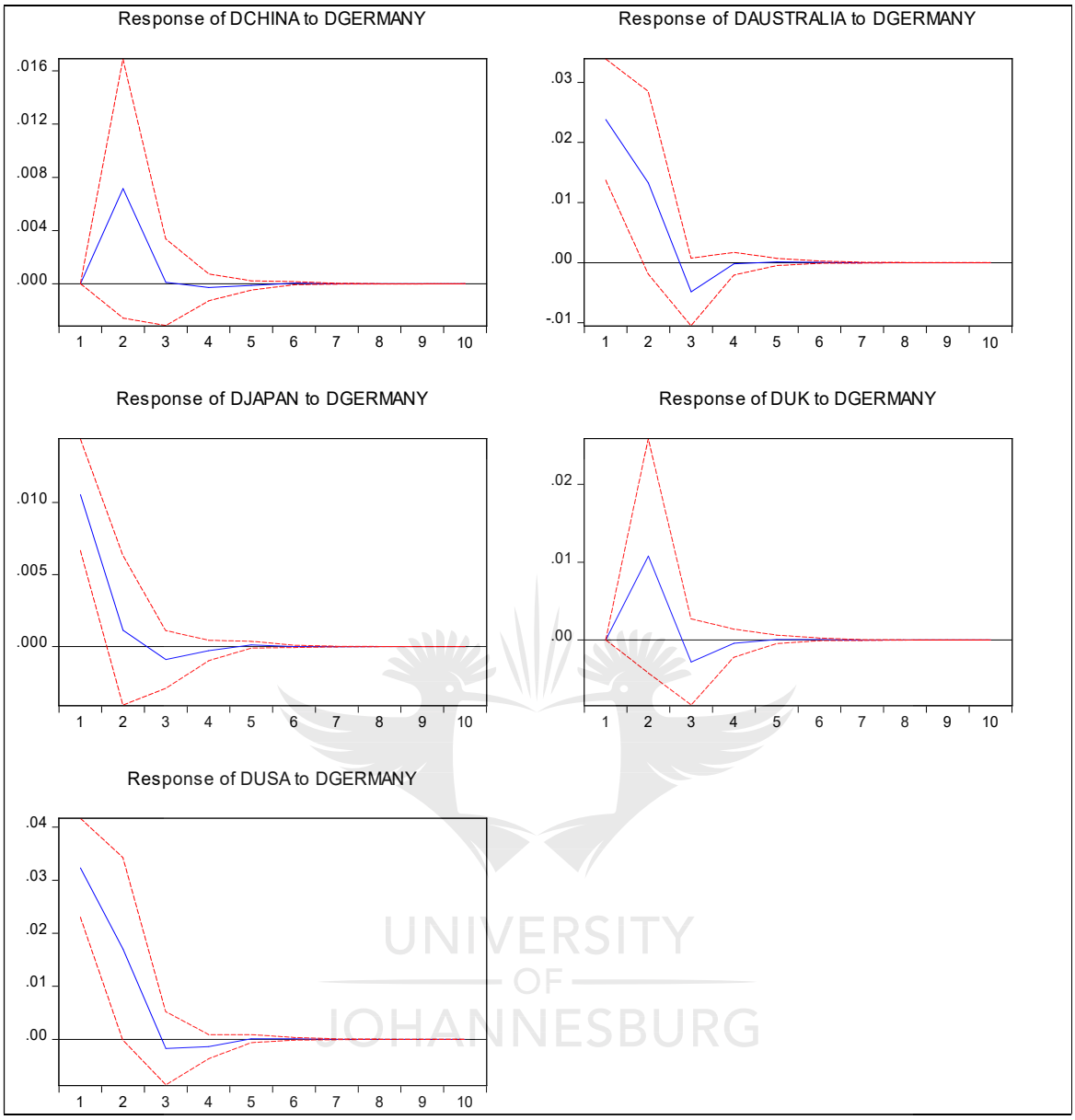

Figure 4:3: Impulse Response Function: Shock to the German bond market

Source: EViews 10

4.9.2 Analysis of a shock to the German bond market

The Chinese market reacted to a shock in the German bond market with no reaction in the first period. It reacted with a 0.007 positive standard deviation shock in the second period. This faded away quickly and was worked through the system by the third period, with no further effects.

The UK bond market had an initial reaction that almost mirrored that of the Chinese bond market. It also experienced no shock in the first period with a positive 0.01 standard deviation in the second period, but then deviated from the Chinese bond market reaction by having a very small negative reaction in the third period, before fully recovering by the fifth period.

The Japanese, Australian and US bond markets all reacted similarly, whilst differing from China and the UK. They all experienced a positive shock of 0.010, 0.025 and 0.032 respectively in the first period, which reduced to 0.002, 0.014 and 0.017 in the second. Henceforth they displayed a similar pattern with a small negative shock in the third period, which continued in the fourth period for Japan and the US. Australia recovered by the fourth period, with Japan and the US recovering in the fifth period.

From a diversification perspective, only the UK bond market reacted similarly to the Chinese bond market. The Australian, Japanese and US bond markets reacted similar to one another, indicating that the Chinese and UK bond market would be good diversification alternatives against the German bond market, when compared to the Australian, Japanese and US markets.

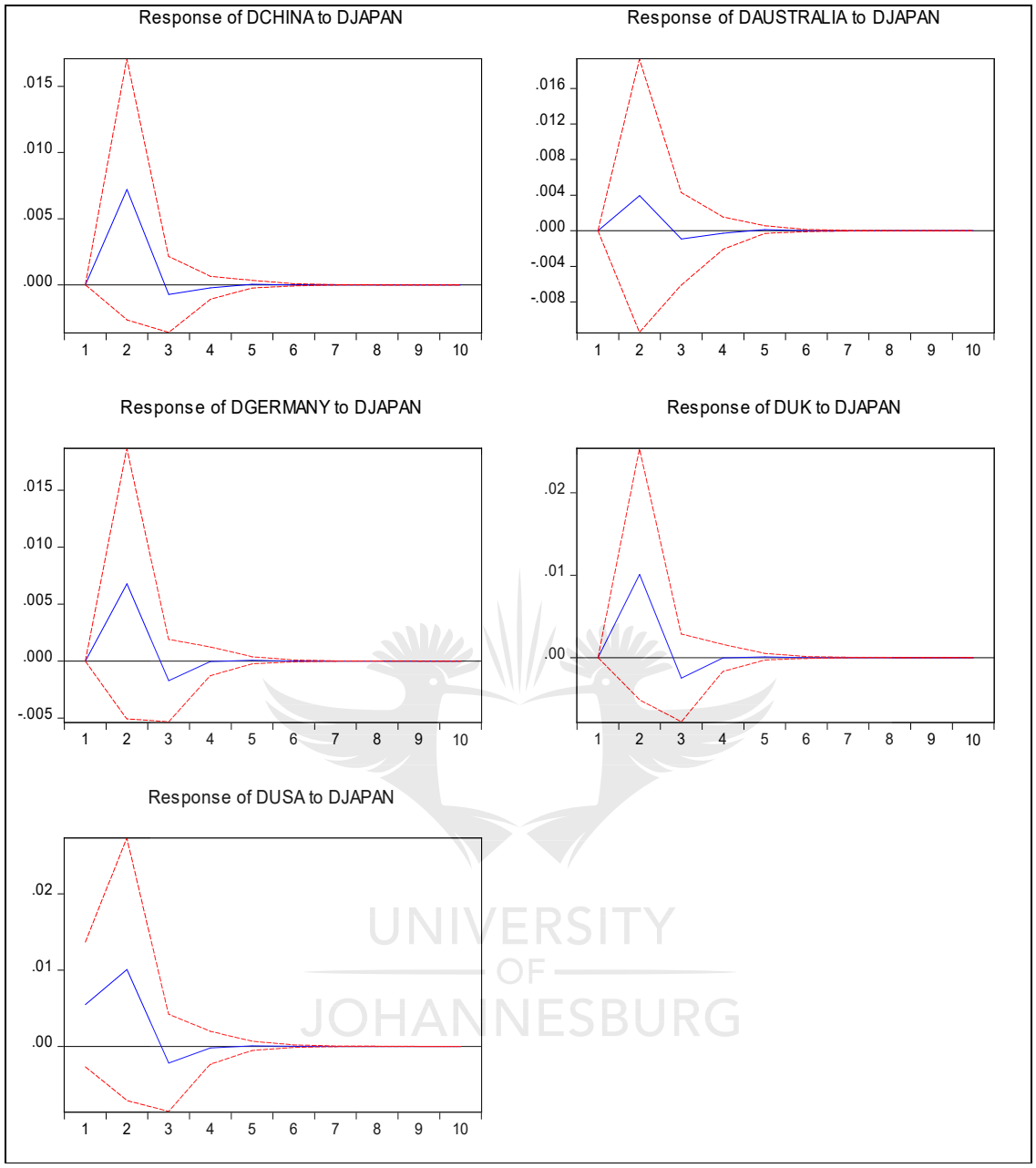

Figure 4:4: Impulse Response Function: Shock to the Japanese bond market

Source: EViews 10

4.9.3 Analysis of a shock to the Japanese bond market

The Chinese bond market reacted to a shock in the Japanese bond market with a no reaction in the first period and a positive 0.07 standard deviation shock in the second period. This was followed by a negative shock of 0.001 in the third period that faded away quickly and was worked through the system by the fifth period, with no further effects.

The German, UK and Australian markets had no reaction in the first period, whilst the US market had a shock of 0.005 in the first period. Thereafter all the developed bond markets reacted similarly in periods two and three, as all were positive in the second period and negative in the third. The second period shocks differed in magnitude from Australia on 0.004, Germany on 0.006 and the UK and US on 0.1. By the third period they had all turned negative and by the fourth period Germany, the UK and the US had recovered, whilst Australia still had a very small negative shock. All markets fully recovered in the fifth period.

From a diversification perspective all the markets followed an almost similar pattern, with the sole exception of the US which was positive in the first period. From the second period onwards, all markets reacted the same. The Chinese bond market followed a similar pattern to the rest and whilst differing in magnitude, does not seem to offer a diversification opportunity from Japan, when compared to the other developed markets in the short run.

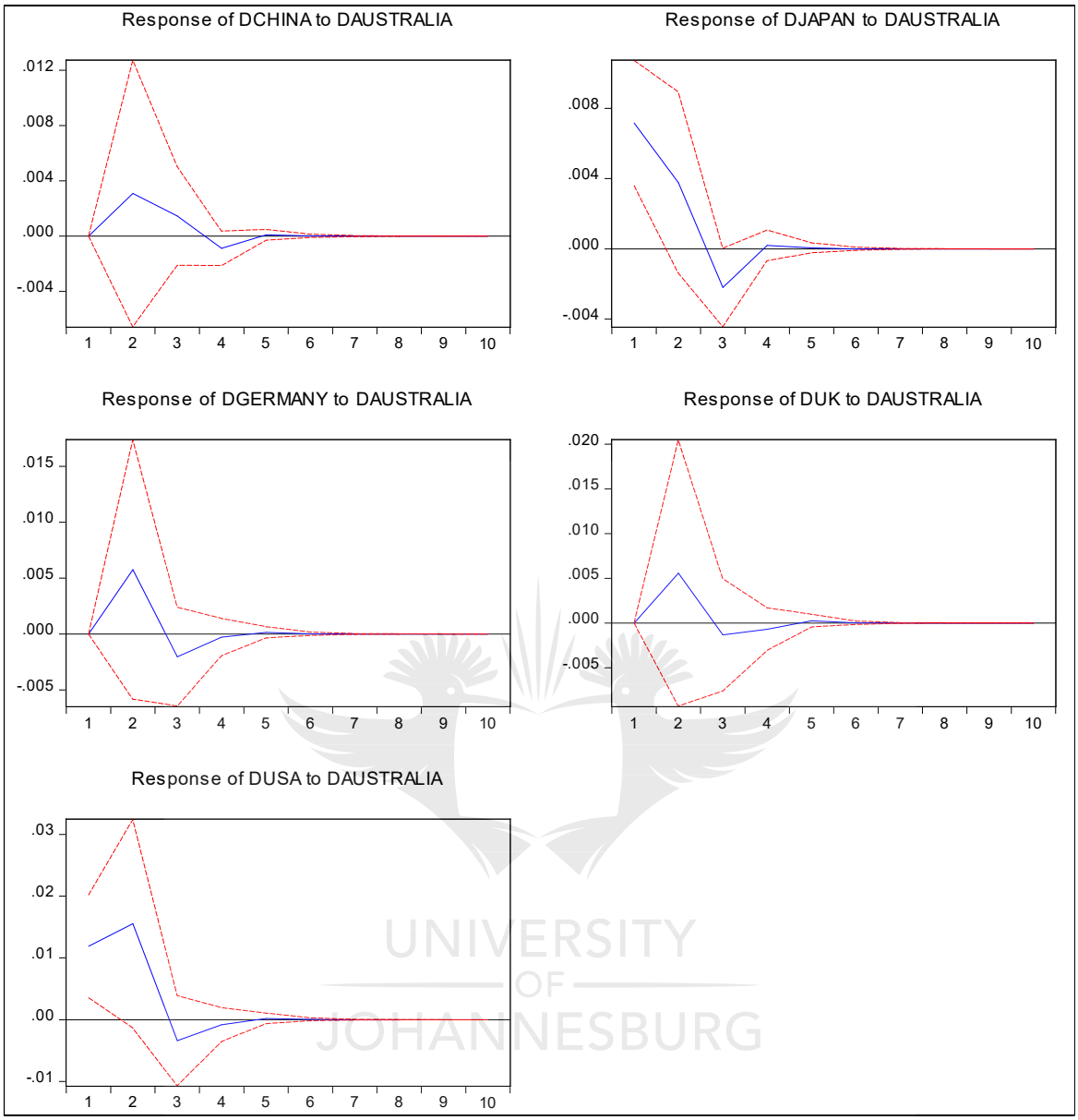

Figure 4:5: Impulse Response Function: Shock to the Australian bond market

Source: EViews 10

4.9.4 Analysis of a shock to the Australian bond market

The Chinese bond market reacted to a shock in the Australian bond market with no reaction in the first period and then a small positive 0.003 standard deviation shock in the second period. This reduced to a 0.002 standard deviation shock in the third period, with a small negative 0.001 shock in the fourth period. All shocks faded away by the fifth period with no further effects.

The German and UK bond markets followed a very similar pattern. Both bond markets had no reaction in the first period and a 0.005 shock in the second period. Both then turned negative in the third period, with the UK's shock slightly smaller. In both cases it was still negative in the fourth period, whilst completely recovering by the fifth. The US followed an almost similar pattern, with the only difference being a positive shock of 0.012 in the first period that increased to 0.016 in the second. Like the UK and German markets, it then moved negatively in the third by 0.002, whilst fading in the fourth period and completely recovering in the fifth.

The Japanese bond market reacted differently with a positive shock of 0.007 in the first period that reduced to a positive shock of 0.003 in the second. Thereafter it turned negative in the third period by 0.002, but again reacted differently to Germany, the UK and the US, as it had a small positive shock in the fourth period. It fully recovered in the fifth period.

From a diversification perspective, China followed an almost similar pattern to the German and UK bond markets and may provide limited diversification opportunities. It did differ from them slightly though as it took one extra period before turning negative. It was positive in the third period, whilst the German and the UK bond markets had both already turned negative. China had a distinctly different reaction to Japan which indicates a potential diversification opportunity. It only displayed the same sign as Japan in one period (second period), yet all that was before and after differed. China also differed from the US in two ways. Firstly, it had no reaction in the first period, whilst the US did. It also took one period longer for the Chinese shock to turn negative and therefore differed from the US in the third period. These two differences could also indicate a diversification opportunity.

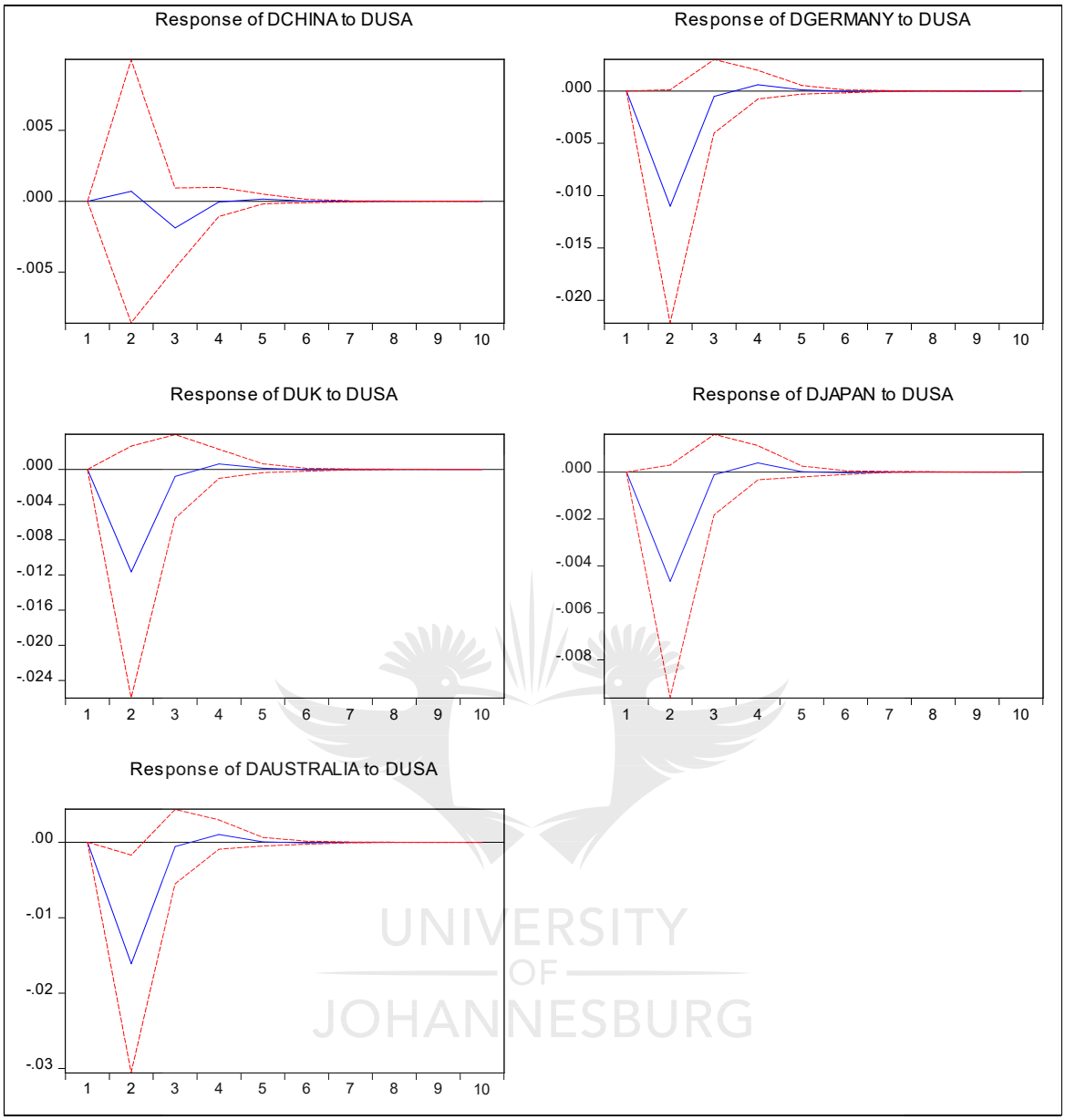

Figure 4:6 Impulse Response Function: Shock to the US bond market

Source: EViews 10

4.9.5 Analysis of a shock to the US bond market

The Chinese bond market reacted to a shock in the US bond market with no reaction in the first period and then a small positive 0.001 standard deviation shock in the second period. This changed to a negative 0.002 standard deviation shock in the third period, which faded by the fourth period with no further effects. The Chinese bond market had almost no reaction to a shock in the US market, which is an indicator that the Chinese bond market could be a potential diversification option for investors in US bond markets.

All the other markets reacted in the same way to shocks in the US market, albeit in different magnitudes. All of them experienced no shock in the first period, a negative shock in the second period, almost no shock in the third period, a very small shock in the fourth period that flattened out in the fifth period. They differed in magnitude in the second period with Germany negative 0.010, the UK negative 0.012, Japan negative 0.004 and Australia negative 0.015. Germany, the UK and Australia had very small negative shocks in the third period, with all markets having very small positive shocks in the fourth. They all recovered by the fifth.

The diversification implications in this test are significant. As discussed, the US is the largest economy in the world with the largest bond market. It is clear that the other developed bond markets reacted in a similar way to a shock in the US bond market. The US bond market was the only bond market to cause an exact pattern of reaction in each of the other bond markets. This is an indication that there exists a definitive short run relationship between the US and other bond markets and that the developed bond markets are highly sensitive to changes in the US bond market. These markets are clearly highly efficient and integrated. Whilst it works through the system relatively quickly, it is noteworthy that only one bond market reacted differently to shocks in the US market and that was the Chinese bond market. The Chinese bond market had a completely different reaction to the other bond markets and this indicates that China, as the second largest economy in the world, offers a good diversification opportunity to investors who hold US bonds.

4.10 VARIANCE DECOMPOSITION

Variance decomposition is often used alongside the impulse response function as is evident in studies such as Borozan (2011) and Grbic (2020) and assists in causing the results of short run relationships to be more robust. Whilst it measures short run relationships by testing for responsiveness, it differs from the impulse response function as it measures the extent of influence that other variables have on the dependent variable (Brooks, 2014). As Borozan describes it: "Variance decomposition measures the percentage of the forecast… that can be attributed to shocks or innovations to each explanatory variable over a series of time horizons. Hence, it also shows how this proportion changes over time." (Borozan, 2011, p. 529). In other words, variance decomposition helps analyse the influence that one variable has on the other variables and what percentage of influence exists (Grbic, 2020).

As with the impulse response function, the variance decomposition is sensitive to the order of the variables and could influence the outcome (Borozan, 2011). It is therefore important that the correct ordering is used. In this study the correct ordering was already determined in the impulse response function and the same Cholesky ordering will be used. A variance decomposition was simulated on that ordering and the results are set forth in Table 4:13.

Table 4:13: Variance decomposition - China

Period	S.E.	AUSTRALIA	GERMANY	JAPAN	UK	USA
1	0.0554	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0566	0.2969	1.5991	1.6242	0.5074	0.0157
3	0.0566	0.3627	1.5953	1.6362	0.5061	0.1265
4	0.0567	0.3869	1.5972	1.6373	0.5069	0.1265
5	0.0567	0.3872	1.5977	1.6373	0.5071	0.1272
6	0.0567	0.3872	1.5977	1.6373	0.5072	0.1272
7	0.0567	0.3872	1.5977	1.6373	0.5072	0.1272
8	0.0567	0.3872	1.5977	1.6373	0.5072	0.1272
9	0.0567	0.3872	1.5977	1.6373	0.5072	0.1272
10	0.0567	0.3872	1.5977	1.6373	0.5072	0.1272

Choleske Odering: China, UK, Germany, Australia, Japan, USA

Source: EViews 10

From the results in Table 4:13, it can be concluded that the developed bond markets had only a minor influence on the Chinese bond market and accounted for no variations in the first period. A 1% of variation in the Chinese bonds can be explained by the variation in the German and Japanese bond markets of around 1.6% and these are the only two markets that had a larger than 1% influence over all time periods. Whilst Japan had the largest influence, it was still small and in no period reached 2%. A 1% variation in China also had little influence over

all periods in the UK, Australia and US bond markets, with no bond market reaching 0.6% over any period. In fact, the US bond market barely had a 0.1% influence over all periods. These findings are in line with the Granger causality test which indicate that there exist no bi-directional relationships between these bond markets.

4.11 SUMMARY

This chapter set out to test the potential for diversification opportunities in Chinese bonds for developed market bond investors. It commenced with a correlation analysis that found strong correlations all round among the bond markets tested. Thereafter, two-unit root tests were conducted to determine the stationarity of the data. It was found that the data was non stationary on I(0) but stationary on I(1). This assisted in using the data in its correct form in subsequent tests and confirmed that cointegration tests could be done.

The unit root tests were followed by the Granger causality test. This test set out to determine if any causality and short run relationships were evident among the Chinese bond market and the developed bond markets. It was found that no bi-directional relationships exist and only a single unidirectional relationship is evident between Japan and China. This is an early indication of a potential diversification opportunity.

After causality was tested, cointegration testing commenced. The first cointegration test applied was the Engle-Granger method. With China as the dependent variable, it found potential cointegration between China-Germany and China-UK. Thereafter, a VAR was run before the Johansen pairwise and Johansen cointegration tests could be conducted. The Johansen cointegration tests found no significant long run relationships between the Chinese bond market and the developed bond markets.

Finally, an impulse response and variance decomposition were simulated to test the effects that shocks would have on the different bond markets. Both these tests came to the same conclusion and further confirmed what had already been proven in the study. They indicated that even though some short run relationships existed, they differ from one another to such an extent that there exist diversification opportunities. The only potential exception was the impulse response to shocks in the Japanese market where the Chinese bond market did not seem to offer the best diversification opportunity.

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Chapter 5 Findings, conclusion and recommendation

5.1 INTRODUCTION

This study set out to determine whether causality, cointegration and short run relationships exist between Chinese government bonds and those of select developed market bonds. In chapter one, the research objectives were defined and research questions developed. Chapter two gave a detailed summary of similar studies that have been done on diversification, bonds and China. It was established that no other studies have tested what this study set out to test. Chapter three indicated how this would be tested and chapter four consisted of the actual testing. This final chapter will bring it all together and conclude the study with the findings.

The rest of this chapter will be structured as follows: a brief reason for undertaking the research will be discussed. Thereafter the chapter will provide a summary of the most important findings that were made in chapter four. This will be the most important part of this chapter as it will offer a conclusion and will indicate that the research questions, that were postulated in chapter one, have been answered. It will discuss the implications of the answered questions as a result. With the research questions answered and the implication for investors discussed, a brief opinion on the contribution of this study will be given, followed by the potential limitations of the study. Finally, a recommendation will be made on further research that could be conducted that can elaborate on this study.

5.2 REASON FOR UNDERTAKING THE RESEARCH

There are three main reasons why this topic was chosen and the subsequent research was done. All three of these reasons were discussed in the literature review in chapter two.

The first was that research on bond markets is often neglected in favour of research on equity markets. This, despite the fact that bond markets have a larger market capitalisation than equity markets and constitute a larger portion of capital markets. This study therefore aimed to expand on a topic in finance that was relatively under-researched.

Secondly, as was confirmed in this study, globalisation has led to limited international diversification opportunities and it is becoming more difficult for international investors and fund managers to invest in assets that are properly diversified. This “nowhere to hide” concept is evident in the global financial crisis and the recent COVID-19 pandemic. Thus, investors increasingly have to look at either alternative asset classes, or other potential investments that did not offer investment opportunities before. Chinese government bonds offer such an opportunity as they only became an investable asset for international investors in 2017. Prior to 2017 it was an option unavailable to most investors. In an increasingly global world, this development potentially opened a wonderful diversification opportunity as China is now the world’s second largest economy.

The third reason is closely linked to the second. As Chinese government bonds are relatively new, limited studies have been conducted on its bonds. This study focussed specifically on diversification opportunities, but it became clear that Chinese government bonds were not yet well researched, even in a wider field such as its influence on Chinese GDP, on exports, inflation etc. This study identified a research gap and attempted to contribute to close this gap.

5.3 SUMMARY OF THE FINDINGS

Since the ground-breaking work by Markowitz (1952) on diversification, there has been a keen interested in the topic as is discussed in the literature review. In chapter two, it is discussed how researchers applied a variety of techniques to find potential diversification within and among asset classes. By the 1960s, international diversification became a highly researched topic and most studies concluded that it is beneficial for investors to diversify globally. By the late 1980s and early 1990s researchers observed a closer movement in international assets and started testing whether international diversification opportunities have evaporated. Most found that they still existed but have reduced. This trend continued and some researchers hold that diversification opportunities had all but diminished by the late 2000s and early 2010s.

By 2017 a new potential diversification opportunity arose as China opened its government bond market to investors. This study set out to determine whether this new opportunity could perhaps create a new opportunity to diversify. To determine the possibility of this opportunity, this study tested whether strong correlation, causality, long run relationships (cointegration) and short run relationships are evident between the Chinese government bond market and those of Australia, Germany, Japan, the UK and the USA.

As an initial test that could easily be compared to previous studies on the topic, a correlation analysis was done and it was found that there is a strong correlation between the markets. Earlier studies that did not yet have more sophisticated tests such as cointegration at their disposal, may have concluded that China does not offer a diversification opportunity. Two deductions could be made from this analysis. The first is that the markets tested in this study were tightly correlated. This was not a surprising finding as studies on globalisation, bonds and other asset classes caused one almost to anticipate this outcome. It is therefore important to run a variety of more sophisticated tests to truly gain a deeper understanding of the underlying relationships. Correlation is a good starting point, but the comovements over long and short periods gave better insights as to the potential for diversification. Secondly, notwithstanding the results, it was found that Chinese government bonds still provided a good diversification opportunity, relative to the developed bond markets.

Further tests were conducted and the first of those was the Granger causality test. This test revealed that there were no bi-directional causalities that existed and that only a single unidirectional relationship was present between Japan and China. This relationship was evident only on a 91% confidence level and not on the usual 95% confidence level. The lack of causality between the markets evidences potential diversification and the first confirmation of a lack of short run relationships. This test also answered the research question about causality between these markets and confirmed that no bi-directional causality existed.

The most important part of this study was the cointegration tests, as they would reveal whether long run relationships existed. Two unit root tests were conducted in the ADF and PP methods and both found the data non-stationary on I(0) and stationary on I(1). This is important as it indicated that cointegration tests could be conducted on this data. The first cointegration test conducted was the Engle-Granger two-step method. This test found that where China was the dependent variable, no cointegration existed among China and Australia, Japan and the US. It did, however, find potential cointegration between China and Germany, as well as between China and the UK. The resultant ECM constructed on Germany and the UK, indicated a very slow movement back to the equilibrium.

For robustness and to overcome some of the shortcomings of the Engle Granger method the Johansen cointegration test was also conducted. To run the Johansen test, a VAR had to be constructed first. The correct lag length, using information criteria, was found be one lag length. Running the Johansen test on a one lag length VAR, the pairwise testing found that no cointegration was evident between China and any of the developed bond markets. The

multivariate Johansen test that followed, found that no cointegration was evident among any of the markets.

The Engle Granger and Johansen methods came to the same conclusion, in that there exists no cointegration between China and the markets of Australia, Japan and the US. They yielded differing results in Germany and the UK. This is not unusual and it was discussed in the literature review that diversification studies on bonds, like that of Allen and Macdonald (1995), found differing results in the different tests. Brooks (2014) indicates that the Johansen test is a superior test. With the Johansen test finding no cointegration, it seems likely that no clear long run relationships exist. This answers the research question in chapter one about whether long run relationships exist. The answer is negative and therefore, diversification opportunities are present.

Finally, an impulse response function and variance decomposition were run on a restated VAR on differenced data. These tests were performed to answer the third and final research question on whether short run relationships were evident. Both came to the same conclusion and found that whilst there was some evidence of short run relationships, the reaction to shocks among the markets, differed to such an extent that diversification was possible even in the short run. This indicated further proof of potential diversification opportunities. The impulse response function showed that China was a good diversification destination when shocks were applied to all bond markets, with the sole exception of Japan.

As was mentioned a number of times during the study, it is important not to take a single test and reach a conclusion, but rather to interpret the results as a whole. This study provided evidence that no causality was evident. Some short run relationships are present in the impulse response function and variance decomposition. Limited potential long run relationships are present in the Engle Granger test and no long run evidence were found by Johansen. When assessed together, China offers relatively better diversification opportunities form a correlation perspective; have no causality; varying short run relationships; and potentially only limited cointegration. Interpreted together, this study thus concludes by answering the research question posed in chapter one, that Chinese government bonds do offer a diversification opportunity to global developed market investors.

5.4 CONTRIBUTION OF THE STUDY

This study mostly contributes to the literature on global government bonds and specifically contributes to literature on Chinese government bonds which is still very under-researched.

This study found that the relatively new opportunity that presents itself to investors in Chinese government bonds, offers a good diversification opportunity to investors in global, developed markets. This is significant as investors can now invest in the second biggest economy in the world and enjoy diversification benefits.

This finding is significant as new investment opportunities such as this, do not present themselves every day. Globalisation and digitalisation have led to investors who are able to invest relatively easily globally. For example, the middle income South African can easily invest their money in global portfolios from the comfort of their own homes. They can simply buy an exchange traded fund on any of the easy-to-use platforms that track the markets in the United States, or any developed (and many emerging) markets. To move money out of South Africa has also become easy, as most banks allow one to open a global account, whereby they can invest in many currencies around the globe. If it is this easy for individual investors to invest all around the world, it is even easier for the big global fund managers to do so. Money can thus move relatively freely and quickly in this day and age. This, coupled with the fact that news now travel at a breakneck speed, makes it very hard for fund managers to "beat the market". It furthermore makes it equally hard for them to find opportunities to diversify their portfolios.

The opening of China's bond market has created a unique opportunity. It may well be the last time that an economy of that size suddenly comes into play for international investors. By now, all the big world economies are open for investment. Investors have been using this opportunity for years. Fund managers now have the opportunity to buy the bonds of the second largest economy in the world (it is only a matter of time before China becomes the largest). To have access to this market that currently offers higher yields than most of that of the developed market world, whilst simultaneously offering a diversification opportunity, is significant for the global investment community. The attractiveness in these bonds are becoming ever more evident: for example, as the Asia Times reported a 145% increase in trading volumes in June 2020, compared to the same period in the previous year (Xu, 2020). This means the monthly trading volume is now around RMB 422.1 billion. The appetite for this asset class is clearly there and the fact that it offers a good diversification opportunity is significant.

5.5 LIMITATIONS

This study has a number of limitations. The first is that it focussed on a relatively short time period when compared to other international bond studies. Other studies often used time

periods of longer than ten years. This study could only use a three-year time period as Chinese government bonds were only opened to investors in 2017.

The second limitation is that it used only five developed bond markets, which led to two secondary limitations. The first is that there are many more developed bond markets that could have been tested. The second is that no other emerging bond markets were tested to determine if Chinese government bonds could potentially offer a diversification opportunity to them.

Finally, this study tested purely for diversification on an academic level and did not consider trading costs, taxes or currency movements.

5.6 RECOMMENDATIONS FOR FURTHER RESEARCH

The limitations of a study are usually a good starting point for further research. In future, this study could be expanded by extending the research period as it grows. It would be interesting to test if Chinese government bonds still present a diversification opportunity by 2025 and 2030 as it progressively becomes a more prominent player on the world's economic stage. The question can be posed as to whether China will in future move closer to developed market bonds, or whether it will continue to follow the path of other asset classes and become more interlinked.

Future studies could potentially test other developed bond markets such as those of Italy, France and Canada that were omitted in this study to determine whether Chinese government bonds also offer a good diversification opportunity from them. Other developing markets could also be used to see if China presents a diversification opportunity for investors and funds that invest exclusively in emerging market debt. Emerging markets generally have higher yields and it could be helpful to understand if China offers a diversification only to low yielding developed markets or also to high yielding emerging markets, such as the other BRICS countries.

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References

Agur, I., Chan, M., Goswami, M. & Sharma, S., 2019. On international integration of emerging sovereign bond markets. *Emerging Markets Reviews,* 38(March), pp. 347-363.

Ahmad, N., Daud, S. & Kefeli, Z., 2012. Economic Forces and the Sukuk Market. *Procedia - Social and Behavioral Sciences,* 65(December), pp. 127-133.

Allen, D. & Macdonald, G., 1995. The long-run gains from international equity diversification: Australian evidence from cointegration tests. *Applied Financial Economics,* 5(1), pp. 33-42.

Allen, F., Qian, J., Qian, M. & Zhao, M., 2009. A Review of China's Financial System and Initiatives for the Future. In: J. Barth, J. Tatom & G. Yago, eds. *China's Emerging Financial Markets.* New York: Springer.

Andrei, D. & Andrei, L., 2015. Vector error correction model in explaining the association of some macroeconomic variables in Romania. *Procedia Economics and Finance,* 22(November), pp. 568-576.

Atkinson, S., 2017. *BBC.* [Online] Available at: https://www.bbc.com/news/business-40477355. [Accessed 25 March 2020].

Bai, J., Fleming, M. & Horan, C., 2013. *The Micostructure of China's Government Bond Market,* New York: Federal Reserve Bank of New York.

Baillie, R. & Bollerslev, T., 1989. Common Stochastic Trends in a System of Exchange Rates. *Journal of Finance,* 64(1), pp. 167-181.

Barnard, C., 2013. *The Substantive Law of the European Union: The Four Freedoms.* 1st ed. Oxford: OUP.

Barr, D. & Priestley, R., 2004. Expected returns, risk and integration of international bond markets. *Journal of International Money and Finance,* 23(1), pp. 71-97.

Barth, J., Caprio Jr, G. & Phumiwasana, T., 2009. The Transformation of China from an Emerging Economy to a Global Powerhouse. In: J. Barth, J. Tatom & Y. Glenn, eds. *China's Emerging Financial Markets: Challenges and opportunities.* New York: Springer, pp. 73-110.

Barth, J., McCarthy, D., Phumiwasana, T. & Yago, G., 2006. Opportunities and Challenges in Asian Bond Markets. In: *Arner D., Park JH., Lejot P., Liu Q. (eds) Asia's Debt Capital Markets. The Milken Institute Series on Financial Innovation and Economic Growth.* 6th ed. New York: Springer, pp. 11-32.

Baxter, M. & Jermann, U., 1997. The international diversification puzzle is worse than you think. *American Economic Review,* 87(1), pp. 170-180.

Belke, A., Dubova, I. & Volz, U., 2017. Bond yield spillovers from major advanced economies to emerging Asia. *Pacific Economic Review,* 23(1), pp. 109-126.

Berger, A., Hasan, I. & Zhou, M., 2009. Institutional Development, Ownership Structure, and Business Strategies: A New Era in the Chinese Banking Industry. In: J. Barth, J. Tatom & G. Yago, eds. *China's Emerging Financial Markets: Challenges and Opportunities.* New York: Springer, pp. 369-401.

Bloomberg. (2020) *Bloomberg Professional.* [Online]. Available at: Subscription Service (Accessed: 17 March 2020)

Borozan, D., 2011. Granger causality and innovation accounting analysis of the monetary transmission mechanism in Croatia. *Post-Communist Economies,* 23(4), pp. 517-537.

Brooks, 2014. *Introductory Econometrics for Finance.* 3rd ed. Cambridge: Cambridge University Press.

Bunda, I., Hamann, A. & Lall, S., 2009. Correlations in emerging market bonds: The role of local and global factors. *Emerging markets review,* 10(2), pp. 67-96.

Campa, J. & Fernandes, N., 2006. Sources of gains from international portfolio diversification. *Journal of Empirical Finance,* 13(4-5), pp. 417-443.

Cappiello, L., Engle, R. & Sheppard, K., 2006. Asymmetric Dynamics in the Correlations of Global Equity and Bond Returns. *Journal of Financial Econometrics,* 4(4), pp. 537-572.

Cayon, B., 2018. *Bizjournal.com.* [Online]
Available at: https://www.bizjournals.com/milwaukee/news/2018/10/03/investment-diversification-the-only-free-lunch-in.html
[Accessed 21 May 2020].

Cheng, H. & Glascock, J., 2005. Dynamic Linkages Between the Greater China Economic Area Stock Markets - Mainland China, Hong Kong and Taiwan. *Review of Quantitative Finance and Accounting,* 24(1), pp. 343-357.

Chow, G., 1993. Capital Formation and Economic Growth in China. *The Quarterly Journal of Economics,* 3(August), pp. 809-842.

Ciner, C., 2007. Dynamic linkages between international bond markets. *Journal of Multinational Financial Management,* 17(4), pp. 290-303.

Dickey, D. & Fuller, W., 1979. Distribution of the estimators for autoregressive time series with a unit root.. *Journal of the American statistical association,* 75(366), pp. 427-431.

DiLellio, J., 2009. What to Do When Traditional Diversification Strategies Fail: A Study on Diversification and Asset Correlation in Up and Down Markets.. *Graziadio Business Review,* 12(4).

Dixon, P., 2015. *The future of almost everything.* London: Profile Books Ltd.

Elazar, K., 2018. *Seeking Alpha.* [Online]
Available at: https://seekingalpha.com/article/4177113-favorite-rule-dont-put-all-your-eggs-in-one-basket
[Accessed 21 May 2020].

Elton, E. & Gruber, J., 1995. *Modern Portfolio Theory and Investment Analysis.* 5th ed. New York: John Wiley and Sons.

Eun, C., Resnick, B. & Sabherwal, S., 2012. *International Finance: Global Edition.* 6th ed. New York: McGraw-Hill Irwin.

Eun, C. & Shim, S., 1989. International transmission of stock market movements. *Journal of Financial and Quantitative Analysis,* 24(2), pp. 241-256.

Fabozzi, F., 2006. CFA Reading 52: Features of Debt Securities. In: *Equity and Fixed Income: CFA.* New York : John Wiley and Sons, pp. 293-318.

Fan, S. & Chan-Kang, C., 2005. *Road development, economic growth, and poverty reduction in China,* Washington DC: International Food Policy Research Institute.

Fletcher, J., Paudyal, K. & Santoso, T., 2019. Exploring the benefits of international government bond portfolio diversification strategies. *The European Journal of Finance,* 25(1), pp. 1-154.

Fogel, R., 2008. *The impact of the Asian miracle on the theory of economic growth.* Chicago: University of Chicago Press.

FTSE Russel Group, 2020. *FTSE Russel.* [Online]
Available at: https://www.ftserussell.com/products/indices/global-fixed-income-indexes
[Accessed 23 March 2020].

Fung, H., Liu, Q. & Zhang, F., 2019. The Development of China's Bond Market. *The Chinese Economy,* 52(1), pp. 107-123.

Granger, C., 1969. Investigating causal relations by econometric models and cross-spectral methods.. *Econometrica: The Journal of the Econometric Society,* 37(3), pp. 424-438.

Grauer, R. & Hakansson, N., 1987. Gains from International Diversification 1986-85 on Portfolios of Stocks and Bonds. *Journal of Finance,* 62(3), pp. 721-739.

Grbic, M., 2020. Stock market development and economic growth: the case of the Republic of Serbia. *Post-Communist Economies,* 32(1), pp. 1-16.

Grubel, H., 1968. Internationally Diversified Portfolios: Welfare Gains and Capital Flows. *American Economic Review,* 58(5), pp. 1299-1314.

Gultekin, M. & Gultekin, B., 1983. Stock market seasonality: International Evidence. *Journal of Financial Economics,* 12(4), pp. 469-481.

Hall, S., 1991. The effect of varying length VAR models on the maximum likelihood estimates of cointegrating vectors. *Scottish Journal of Political Economy,* 38(4), pp. 317-323.

Hanemann, T. & Huotari, M., 2016. *A new record year for Chinese outbound investment in Europe.,* Berlin: The Mercator Institute for China Studies.

Holder, M., 1999. The Euro impact on European financial markets. *Managerial Finance,* 25(11), pp. 27-34.

Huang, H. & Zhu, H., 2009. The Chinese Bond Market: Historical Lessons, Present Challenges, and Future Perspectives. In: *China's Emerging Financial Markets: Challenges and Opportunities.* New York: Springer, pp. 523-546.

Iben, T. & Litterman, R., 1994. Have the Benefits of International Diversification Diminished?. *The Journal of Fixed Income,* 4(2), pp. 27-34.

International Monetary Fund., 2020. *World Economic Outlook,* New York: International Monetary Fund.

International Monetary Fund, 2011. World economic outlook: Slowing growth and rising risks.

Johansen, S., 1988. Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control,* 12(2-3), pp. 231-254.

Kalra, R., Stoichev, M. & Sudaram, S., 2004. Diminishing gains from international diversification. *Financial Services Review,* 13(3), pp. 199-213.

Kasa, K., 1992. Common stochastic trends in international stock markets. *Journal of Monetary Economics,* 29(1), pp. 95-124.

Kocenda, E. & Cerny, A., 2015. *Elements of Time Series Econometrics: An Applied Approach.* 3rd ed. Prague: Charles University.

Kroeber, A., 2016. *China's Economy. What everyone needs to know..* 1st ed. New York: Oxford University Press.

Levy, H. & Lerman, Z., 1988. The Benefits of International Diversification in Bonds. *Financial Analysts Journal,* 44(5), pp. 56-64.

Levy, H. & Sarnat, M., 1970. International Diversification of Investment Portfolios. *American Economic Review,* 60(September), pp. 668-675.

Leybourne, S. & Newbold, P., 1999. The behaviour of Dickey–Fuller and Phillips–Perron tests under the alternative hypothesis. *Econometrics Journal,* 2(1), pp. 92-106.

Li, G. & Zhou, H., 2016. The Systematic Politicization of China's Stock Markets. *Journal of Contemporary China,* 25(99), pp. 422-437.

Lin, J., 2011. *China and the Global Economy.* San Francisco , Asian Economic Policy Conference.

Lintner, J., 1965. Security Process, Risk and Maximal Gains from Diversification. *Journal of Finance,* 20(December), pp. 587-615.

Lütkepohl, H., 2010. Variance Decomposition.. In: D. S.N. & B. L.E., eds. *Macroeconometrics and Time Series Analysis.* London: Palgrave Macmillan, pp. 369-371.

Lütkepohl, H., Saikkonen, P. & Trenkler, C., 2002. Maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process. *The Econometrics Journal,* 4(2), pp. 287-310.

Maggiora, D. & Skerman, R., 2009. *Johansen Cointegration Analysis of American and European Stock Market Indices: An Empirical Study.* Lund, Lund University.

Manyapu, C., 2018. Modern evolution of the Chinese Bond Market. *Wharton Research Scholars: Unpublished Undergraduate Research.*

Markowitz, 1952. Portfolio Selection. *Journal of Finance,* 7(1), pp. 77-91.

McCauley, R. & Jiang, G., 2004. *Diversifying with Asian local currency bonds,* Basel: Bank for International Settlements.

Mills, T. & Mills, A., 1991. The international transmission of bond market movements. *Bulletin of Economic Research,* 43(1), pp. 273-282.

Min, C., 2019. *Applied Econometrics: A Practical Guide.* 1st ed. London: Routhledge.

Moosa, I., Tawadros, G. & Hallahan, T., 2015. The effectiveness of international diversification: whole markets versus sectors. *Applied Economics,* 47(6), pp. 641-622.

Navarro, P. & Roach, S., 2012. China's Currency Manipulation: A Policy Debate. *National Bureau of Economic Research Inc,* 175(3), pp. 27-37.

O'Sullivan, A. & Sheffrin, A., 2003. *Economics: Principles in Action.* New Jersey: Pearson Prentice Hall.

Peterson, J., 2019. *Schwab.* [Online]
Available at: https://www.schwab.com/resource-center/insights/content/why-global-diversification-matters.
[Accessed 11 March 2020].

Pham, T., 2015. China's sovereign bond yield: Some lessons. *Applied Economic Letters,* 22(3), pp. 223-227.

Phumiwasana, T., 2003. Financial Structure, Economic Growth and Stability. *Claremont Graduate University; Department of Economics; PHD Dissertation.*

Piljak, V., 2013. Bond markets co-movement dynamics and macroeconomic factors: Evidence from emerging and frontier markets.. *Emerging Markets Review,* 17(December), pp. 29-43.

Quinlan, C., 2011. *Business Research Methods.* 1st ed. Hampshire: South-Western Cengage Learning.

Reinhart, C. & Rogof, K., 2009. *This Time is Different: Eight Centuries of Financial Folly.* Princeton: Princiton University Press.

Sharpe, W., 1964. Capital Assets Prices: A Theory of Market Equilibrium Under Conditions of Risk. *Journal of Finance,* 19(September), pp. 425-442.

Sims, C., 1980. Macroeconomics and Reality. *Econometrica,* 48(1), pp. 1-48.

Singal, V., 2013. Portfolio Risk and Return: Part I. In: C. Institute, ed. *Corporate Finance and Portfolio Management: CFA Institute.* New York: John Wiley and Sons, pp. 259-323.

Skintzi, V. & Refenes, A., 2006. Volatility Spillovers and Dynamic Correlation in European Bond Markets. *Journal of International Financial Markets, Institutions and Money,* 16(1), pp. 23-40.

Smith, K., 2002. Government Bond Market Seasonality, Diversification and Cointegration: International Evidence. *The Journal of Financial Research,* 25(2), pp. 203-221.

Solnik, B., Boucrelle, C. & Fur, Y., 1996. International market correlation and volatility. *Financial Analysts Journal,* 52(5), pp. 17-34.

Solnik, H., 1974. Why Not Diversify Internationally Rather Than Domestically?. *Financial Analysts Journal,* 30(4), pp. 48-54.

Verspagen, B., 1995. Convergence in the Global Economy: A Broad Historical Viewpoint.. *Structural Change and Economic Dynamics,* 6(1), pp. 143-165.

Wegner, T., 2007. *Applied Business Statistics.* 2nd ed. Cape Town: Juta.

World Population Review, 2020. *worldpopulationreview.* [Online]
Available at: https://worldpopulationreview.com/countries/countries-by-gdp/
[Accessed 23 March 2020].

Xu, N., 2020. *Asia Times.* [Online]
Available at: https://asiatimes.com/2020/07/bond-connect-turnover-rises-145-in-june/
[Accessed 20 October 2020].

Yang, J., 2005. Government bond market linkages: Evidence from Europe. *Applied Financial Economics,* 15(9), pp. 599-610.

Zhang, N., Guo, M. & Zheng, X. Z., 2012. China: Awakening Giant Developing Solutions to Population Aging. *International Spotlight,* 52(5), pp. 589-596.

Zimmermann, H., Drobetz, W. & Oertmann, P., 2003. *Global Asset Allocation:New Methods and Applications.* 1st ed. New Jersey: John Wiley and Sons.